B I D D I N G D O C U M E N T

for

The Work of Design, Engineering, Construction and Commissioning 10 MLD Sewage Treatment Plant with Biological Nutrient Removal (BNR) at Anjanapura-2 BDA layout with 10 MLD TSPS, Pumping Main and Operation & Maintenance for Seven Years.
(DBO contract)

Contract Package – BWSSB - ANJ-2 - BDA

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PART 10B

PARTICULAR TECHNICAL SPECIFICATIONS FOR CIVIL, STRUCTURAL AND PUMPING MAIN/SEWER NETWORK

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PART-10B

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PART-10B

PARTICULAR TECHNICAL SPECIFICATIONS FOR CIVIL, STRUCTURAL AND SEWER NETWORK

A. Standard Basic Specifications

The "Standard Basic Specifications" Part-10A shall be followed for construction of General Works under this contract of BWSSB. Specifications for additional specialized items of civil works are as set out in Part 10B, Particular Technical Specifications, of this Section.

In the event of any discrepancy between the provisions of the Standard Basic Specifications and the Particular Technical Specifications, the provisions of the Particular Technical Specifications shall prevail.

B. Particular Technical Specifications for STP, TSPS& Connected Works

1.0 Design Submissions

Before proceeding with design and drawing preparation, the Contractor shall submit detailed general philosophy of design (Design Basis Report) of various parts of (all) the structures and equipment foundations along with explanatory sketches for review. Only after the review and incorporation of comments on the general philosophy, as offered during the review, the Contractor shall submit any design document and/or drawing for review and approval for construction.

1.1 Design Philosophy

Following are the details which are to be included in the general design philosophy document submission:

1. Design assumptions/philosophy for Liquid Retaining Structures with various boundary conditions as applicable

2. Design assumptions/philosophy for buildings

3. Design assumptions/philosophy for all other structures

4. Standard General Notes shall include material properties (grade, strength, unit weight etc.), development lengths, lap/splice lengths, Anchorage lengths under tension and compression, clear cover, water proofing specifications, legend used etc.

1.2 Standard Details

Following typical details shall also be submitted for approval prior to proceeding with detailed design:

1. Reinforcement detail showing the development length at Column/Footing intersection, Column and Roof beam intersections, Walls and Base slab intersections, Walls and cover slab intersections.

2. Detailing of the reinforcement for columns, beams, beam/column intersection, footing/column intersection, and Slabs as per relevant code provisions/requirements depending upon the assumptions made in the design as applicable.

3. Reinforcement detail for cut-outs in slabs and walls with maximum size of cut-outs

4. Reinforcement detail at top of RCC trench walls showing edge/seating angles

5. Pouring sequence of concrete and standard details for construction joints, expansion joints, contraction joints, etc.

6. Details of Opening/Manholes and Rungs to be placed in the tanks

7. Detail for rain water drainage down takes at terrace slab and water proofing at roof/sunken slabs

8. Detail for storm water drain, Roads, plinth protection and entrance ramps to buildings

9. Detail for Handrails and fixing detail of handrail to concrete, Steel Ladders and fixing detail of ladders to Walls/Concrete, Cage ladders, Boundary walls, Fencing and Gates, etc.,

1.3 Submission

Contractor shall submit the detailed design and drawings only after items mentioned under clause 1.1 and 1.2 are approved or as directed by the Engineer

Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted to the Engineer. Separate design calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and shall not be accepted by the Engineer.

Submissions of detailed design calculations and Good for Construction drawings shall include the following as a minimum:

A. Detailed Design Calculations
    1. One (1) Copy of a Compact Disc (CD) containing electronic files relevant to the structure's modelling, analysis and design calculations (Microsoft Excel, STAADPro, etc.). Files submitted shall be in editable format.

    2. Print copy (7Copies) of the contents as submitted in the Compact Disc.

B. Good for Construction Drawings
    1. One (1) Copy of a Compact Disc (CD) containing AutoCAD files (Civil General Arrangement, Structural Dimensions and Reinforcement Details) pertaining to the structure. Files submitted shall be in editable format.

    2. Print copy (7Copies) of the contents as submitted in the Compact Disc. Prints to be submitted on A1 Size Sheet as a minimum or A0 Size Sheet when required by the employer.

    3. Bar-bending schedule indicating the number, shape and size of the rebars shall be submitted as part of the Reinforcement Details.

4. Detailed drawing showing the location, number and depth of inserts shall be included for any structural steel inserts/Metal inserts in the structure such as rungs, bolted connections for ladders/railings, etc.

5. Location of Construction Joints and pour sequence shall be included on the drawing for base slabs, walls and top slabs.

6. Revised drawings shall be submitted by clouding at the location with the latest revision number and also show the history of revisions in a table format just above the title block.

The design considerations described here under establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed. The Contractor shall also take care to check the stability of partly completed structures.

1.4 Design Standards

All the designs shall be based on the latest Bureau of Indian Standard (BIS) Specifications or Codes of Practice. The design standards adopted shall follow the best modern engineering practice in the field based on any other International Standard or specialist literature subject to such standard reference or extract of such literature in the English language being supplied to and approved by the Engineer. In case of any variation or contradiction between the provisions of the BIS Standards or Codes and the specifications given along with the tender document, the provision given in this Specification shall be followed.

All reinforced concrete structural design shall generally conform to the following publications of the Indian Standards Institution:

IS:456 : Code of Practice for plain and reinforced concrete
IS:875 : Code of Practice for design loads for buildings and structures (Part I to V)
IS:3370 : Code of Practice for concrete structures for the storage of liquids (Part I to IV)
IS:1893 : Criteria for earthquake resistant design of structures (Part 1to 4)
IS: 2974 : Code of Practice for design and construction of machine foundations (Part 1 to 4)
IS: 2911 : Code of practice for Design and construction of Pile foundations. (Parts 1 to 4)
IS:13920 : Ductile Detailing of Reinforced Concrete Structures subjected to Seismic forces- Code of Practice.
IS: 4326 : Code of Practice for Earthquake Resistant Design and Construction of Buildings
IRC: 6 : Standard specification and Code of Practice for road bridges Loads and Stresses
SP: 16 : Design Aids for Reinforced Concrete to IS 456
SP: 34 : Handbook on Concrete Reinforcement and Detailing.
SP: 23 : Handbook on Concrete Mixes.

All structural steel design shall generally conform to the following publications of the Indian Standards Institution:

I.S: 800 : Code of Practice for general construction in steel
I.S: 806 : Code of Practice for use of steel tubes in general building construction

SP: 38 : Handbook of Typified Design of Structures with Steel Roof Trusses

1.5 Design Life

The design life of all structures and buildings shall be 60 years.

1.6 Design Loadings

All buildings and structures shall be designed to resist the worst combination of the following loads/stresses under test and working conditions; these include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads.

1.7 Dead Load

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment's and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included, but excluding contents, shall be considered.
Dead loads shall be in general as per I.S. 875 Part (I). However, the following **minimum loads** shall be considered in design of structures:

(i)	Weight of water	9.81 kN/m^3
(ii)	Weight of soil (irrespective of strata available at site and type of soil used for filling etc). However, for checking stability against uplift, actual weight of soil as determined by field test shall be considered	20.00 kN/m^3
(iii)	Weight of concrete	24.00 kN/m^3
(iv)	Weight of reinforced concrete	25.00 kN/m^3
(v)	Weight of brickwork (exclusive of plaster)	22.00 N/m^2 per mm thickness of brickwork
(vi)	Weight of Solid Concrete Block work (exclusive of plaster)	24.00 N/m^2 per mm thickness of block work
(vii)	Weight of plaster to masonry surface	18.00 N/m^2 per mm thickness
(viii)	Weight of granolithic terrazzo finish or rendering screed, etc.	24.00 N/m^2 per mm thickness
(ix)	Weight of sand (filter media)	26.0 kN/m^3
(x)	Weight of alum blocks	24.20 kN/m^3

1.8 Live Load

Live Load (LL) shall include the superimposed loads due to the use/occupancy of the structure/building not including dead, wind or earthquake load. Live loads shall be in general as per I.S. 875 Part (II). However, the following **minimum live loads** shall be considered in the design of structures:

(i) Live load on roofs (accessible by staircase) : 1.50 kN/m^2

(ii) Live load on floors supporting equipment such as pumps, blowers, compressors, valves etc. : 10.00 kN/m^2

(iii)	Live load on all other floors walkways, stairways and platforms	:	5.00 kN/m^2
(iv)	Live load on Toilet areas	:	2.00 kN/m^2
(v)	Surcharge for underground structures Including channels, sumps, cable & pipe trenches etc.	:	20.00 kN/ m^2

In the absence of any suitable provisions for live loads in BIS Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of the Engineer prior to starting the design work. Apart from the specified live loads or any other load due to material

stored, any other equipment load or possible overloading during maintenance or erection/construction shall be considered and shall be partial or full whichever causes the most critical condition.

1.9 Wind Load

Wind loads shall be as per I.S. 875 Part (III).

1.10 Earthquake Load

This shall be computed as per I.S. 1893. An importance factor appropriate to the type of structure shall be considered for design of all the structures. For design of all Process buildings and structures an importance factor of 1.75 shall be adopted.

1.11 Dynamic Load

Dynamic loads due to working of plant items such as pumps, blowers, compressors, switch gears, travelling cranes, etc. shall be considered in the design of foundation of such structures. As a guide, the mass of the foundation should be at least 2.5 times the mass of the whole machine or as provided by the manufacturer/Vendor for dynamic analysis.

1.12 Vehicular Wheel Load

For any structure or pipeline below the roads, Class A loading of IRC 6 shall be considered.

1.13 Joints

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure. However, contraction joints shall be provided at specified locations spaced not more than 7.5 m in both right angle directions for walls and rafts.

Expansion joints of suitable gap at suitable intervals not more than 30 m shall be provided in walls, floors and roof slabs of liquid retaining structures.

Construction joints shall be provided at right angles to the general direction of the member. The locations of construction joints shall be decided on convenience of construction.

To avoid segregation of concrete in walls, vertical construction joints are normally to be provided at corners and junction of walls and in Base slab. PVC water stops of 150mm width shall be used for walls and 230mm width for base slabs.

1.14 Design Criteria for Underground or Partly Underground Liquid Retaining Structures

Water level is assumed at the ground level for design of all the structures. All underground or partly underground liquid containing structures shall be designed for the following conditions:

(i) Any structure in contact with water, submerged water or flowing water shall be designed in accordance with provisions made in IS3370.

(ii) Liquid depth up to full height of wall: no relief due to soil pressure from outside to be considered. Structure empty (i.e., empty of liquid, any material, etc.): full earth pressure and surcharge pressure wherever applicable, to be considered.

(iii) If water table exists, earth pressure to be considered for submerged soil conditions with reference to geotechnical recommendations, approved by the Engineer.

(iv) Partition wall between dry sump and wet sump: to be designed for full liquid depth up to full height of wall.

(v) Partition wall between two compartments: to be designed as one compartment empty and other full.

(vi) Structures shall be designed for uplift in empty conditions with the water table considered at FGL.

(vii) Walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads (Hydrodynamic Impulsive Pressure).

(viii) For general retaining walls and large sized tanks where the walls are designed as retaining walls, sliding check shall also be performed along with over turning checks.

Overturning: The stability of a structure as a whole against overturning shall be ensured so that the restoring moment shall be not less than the sum of 1.2 times the maximum overturning moment due to the characteristic dead load and 1.4 times the maximum overturning moment due to the characteristic imposed loads. In cases where dead load provides the restoring moment, only 0.9 times the characteristic dead load shall be considered. Restoring moment due to imposed loads shall be ignored.

(ix) **Sliding:** The structure shall have a factor against sliding of not less than 1.4 under the most adverse combination of the applied characteristic forces. In this case only 0.9 times the characteristic dead load shall be taken into account as per IS codes.

(x) Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. The stability of the structure should be checked against uplift using Factor of safety of 1.2. The individual members shall be designed for stresses due to uplift forces.

(xi) All the liquid retaining structures shall be design for maximum design crack widths of 0.1mm for direct tension and flexure.

(xii) In case of Large and Deep Underground Tanks, the analysis can be carried by Finite Element Method using STAAD.Pro or any other equivalent software predominantly used and accepted in the industry.

1.15 Foundations

(i) The minimum depth of foundations for all structures, equipments, buildings and frame foundations and load bearing walls shall be as per IS 1904 but in any case this shall not be less than 1.0 meter in the original soil.

(ii) Maximum safe bearing capacity of soil strata shall be taken as determined by the Bidder through his own independent investigations. Geotechnical reports of proposed sites covered under the contract are available with the employer for reference. It may be used by Contractor as part of, in addition to, or in lieu of such investigations at his own risk.

(iii) The Bidder shall ensure the technical feasibility of the offer submitted after visiting the sites and conducting independent investigations. It must be clearly understood by the bidder that as the contract is Design , Build and Operate, the contractor shall be required to design and execute every such item(s) of work(s) which are considered required or necessary for the satisfactory completion and functioning of the entire work, commissioning of electro-mechanical equipment , Instrumentation, SCADA systems, trial run and operation and maintenance , and any other items required but not specified in the bid document, but are essential to complete the scheme. Nothing extra or additional shall be paid to the contactor on account of his failure of understanding.

(iv) Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.

(v) Special attention is drawn to danger of uplift being caused by the ground water table. All underground structural slabs shall be designed for uplift forces due to ground water pressure.

(vi) EGL (Existing ground level) and FGL (Finished ground level) shall be marked on all drawings showing foundation/sub-structure details and related design documents.

(vii) Machine/static equipment foundations shall be separated from adjoining parts of buildings, other foundations and floor/pavement slabs. Joints at floor/pavement slabs shall be suitably sealed.

(viii) Foundations and structures for machines subject to vibrations shall be so proportioned that the amplitude and frequency of the foundation/structure are within the permissible limits as per relevant BIS codes (or as required by the machine vendor).

(ix) Machine foundations shall be designed and detailed as per IS: 2974. All appendages to such foundations shall be reinforced suitably to ensure integral action.

(x) Pile Foundations - Design, Testing and Execution of piles shall be considered as per provision of relevant codes (conforming to latest version of IS: 2911), and in compliance with the Geotechnical report recommendations as applicable.

1.16 Design Requirements

The following are the design requirements for all reinforced or plain concrete structures:

a) All blinding and leveling concrete shall be a minimum 100 mm thick in concrete grade M10.

b) All liquid retaining reinforced concrete structures, concrete shall be of a minimum M30 grade and Buildings, shall be of a minimum M25 grade (Footings, Plinth Beams, Columns, Slab and beams, etc., i.e. which are other than liquid retaining structures). Further, if there are any liquid retaining RCC tanks coming up with in the buildings, concrete shall be of minimum M30 grade for such RCC tanks also.

c) The reinforced concrete for liquid retaining structures shall have a minimum cement content of 400 kg/m^3 for M30 grade concrete and building structures shall have minimum cement content of 360 kg/m^3 with M25 grade concrete. Reinforced concrete shall have maximum slump of 100 mm and maximum water cement ratio of 0.48.

d) The minimum clear cover to all reinforcement including stirrups and links shall be 60 mm for all liquid retaining structures except for Launders/Gutter Slabs cover shall be 45mm. As design consideration to control crack, though general requirements of IS 3370 shall be followed, permissible crack width shall be limited to 0.1 mm for liquid retaining structures.

e) The minimum amount of reinforcement in each of the two directions at right angles within each surface zone should be provided as per clause 8.1 of IS 3370 (Part 2):2009. Definition of surface zones is clearly shown in Figure 1 and Figure 2 of IS 3370 (Part 2): 2009. For slabs, minimum of 10 mm dia bars shall be used to avoid any deformation of lesser diameter bars under loads prior to construction. Any liquid retaining structures which are more than 165mm thickness shall have reinforcement on both the faces..

f) The minimum cover to the main reinforcing bars for different members

1. Non–liquid retaining structures shall be as follows unless stated otherwise:

Slab (Floor, Roof, Canopy, and Staircase)	30 mm
Shell roof for Filter house/Clarifiers	25 mm
Beams (Sides, Bottom & Top)	40 mm
Lintels (all around)	30 mm
Columns	50 mm
Pedestals (in contact with earth)	50 mm
Basement wall, Retaining walls	
i) Face in contact with earth	50 mm
ii) Interior face	40 mm
Foundations	50 mm

2. Liquid retaining structures shall be as follows unless stated otherwise:

Walls – Face in contact with earth	60 mm
Walls – Face in contact with water	60 mm
Base slab in contact with water	60 mm
Base slab in contact with soil	60 mm
Launders/Gutter slabs	45 mm
Roof slab	45 mm
Manhole	50 mm

g) For reinforced concrete structures, reinforcement shall be HYSD-CRS (Corrosion Resistant Steel) of Grade Fe 500. All physical and chemical properties of this Fe 500 grade steel shall confirm to IS: 1786-2008. Welded wire fabric shall conform to IS: 1566 as shown or specified on the drawing. The CRS (corrosion resistant steel) index shall be at least 1.35 when tested for Salt Spray test as per "ASTM B 117 – 2009 test procedure for 120 hours when compared with the Fe 500 normal reinforcement bars and with same bar diameter. All test results (including physical and chemical properties and salt spray tests) have to be produced for the respective bar diameter for each consignment of steel delivered at site and at a frequency of every 20 Metric Tons.

h) Reinforcement bars and structural steel to be procured only from Primary steel producers/Integrated Steel Plants such as SAIL/RINL/JSW/SHYAM STEEL/TATA STEEL using iron ore as the basic raw material and having in-house iron making facilities followed by production of liquid steel and crude steel with in-house rolling, adopting BF-BOF route or DRI-EAF technology as per Ministry of Steel guidelines. No Re-rolled material/secondary steel shall be accepted or allowed for any structural works. 7The steel manufacturing company should have latest ISO accreditation for Quality Management System.

i) All buildings shall have a minimum 1 meter wide, minimum 100 mm thick plinth protection paving in M15 grade concrete. Plinth protection shall be supported on well compacted strata of soling about 150mm/ plain cement concrete as required.

j) All pipes and ducts laid below the structural plinth and road works shall be surrounded with concrete of grade M15 having minimum 150 mm thick concrete or D/4 (D = outer dia. of pipe) thickness whichever is more.

k) Use of pressure relief valves to reduce uplift pressure due to ground water table shall not be allowed.

l) Detailing of the reinforcement shall be considered as per latest Indian code of practices and special publications as applicable.

m) Any structure or pipeline crossing below roads shall be designed for Class A of IRC loading.

n) Sliding layer or slip layer shall be provided between sub base and structural slab (Raft). Polythene sheets of 500 microns shall be provided as sliding layer as per IS specification.

o) Water tightness testing of liquid retaining structures shall be done in accordance with IS: 3370, (Part I) - 2009. It is described in Clause 1.31 of this document. The depth of water for testing shall be as per design depth.

p) A layer of 450mm thick rubble packing with approved stone, set in regular lines, hand-packed, filling the interstices with approved small stone chips and sand, consolidating by ramming or compacting with heavy roller after watering including spreading of 12mm layer of stone grit on top shall be carried out for all building works below grade slabs/rafts/footings under water logged conditions/high water table conditions.

The following minimum thicknesses shall be used for different reinforced concrete members, irrespective of design thicknesses:

(i)	Walls for liquid retaining structures	:	250 mm
(ii)	Roof slabs for liquid retaining structures	:	200 mm

	(Other than flat slabs)		
(iii)	Bottom slabs/Raft for liquid retaining structures	:	300 mm
(iv)	Floor slabs including roof slabs, walkways, canopy slabs	:	125 mm
(v)	Walls of cables / pipe trenches, underground pits etc.	:	200 mm
(vi)	Column footings	:	300 mm
(vii)	Parapets	:	100 mm
(viii)	Precast trench cover, Chajja and all fascias	:	100 mm
(ix)	Column Dimension		
	a) Exceptional case (Based on any specific requirement)		
	i) To match with width of block masonry wall	:	200mm
	ii) To match with width of brick masonry wall	:	230mm
	b) In general case	:	300mm
(x)	Beam (To match with width of block masonry wall)	:	200mm
(xi)	Launder Base Slab/Baffle walls	:	200 mm
(xii)	Launder Vertical Wall, Baffle Wall, Gutter Slab	:	175 mm
(xiii)	Grade Slabs	:	200 mm

1.17 Materials in General

The term "materials" shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the Works.

Except as may be otherwise specified for particular parts of the works the provision of clauses in "Materials and Workmanship" shall apply to materials and workmanship for any part of the works.

All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.

As soon as practicable after receiving the order to commence the Works, the Contractor shall inform to the Engineer of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of the Engineer which may be withheld until samples have been submitted and satisfactorily tested. The Contractor shall thereafter keep the Engineer informed of orders for and delivery dates of all materials.

Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination failing which such damaged materials shall be rejected and shall not be used on any part of the Works under this contract.

1.18 Samples and Tests of Materials

The Contractor shall submit samples of such materials as may be required by the Engineer and shall carry out the specified tests directed by the Engineer at the Site, at the supplier's premises or at a laboratory approved by the Engineer.

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer.

The Contractor shall give the Engineer seven days' notice in writing of the date on which any of the materials shall be ready for testing or inspection at the supplier's premises or at a laboratory approved

by the Engineer. The Engineer shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by the Engineer to carry out such a test on a mutually agreed date in his presence. The Contractor shall in any case submit to Engineer within seven days of every test such number of certified copies (not exceeding six) of the test results as the Engineer may require.

Approval by the Engineer as to the placing of orders for materials or as to samples or tests shall not prejudice any of the Engineer's powers under the Contract.

The provisions of this clause shall also apply to materials supplied under any nominated sub-contract.

1.19 Standards

Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current on the date of submission of the tender.

Where the relevant standard provides for the furnishing of a certificate to the Engineer, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificate and forward it to the Engineer.

The specifications, standards and codes listed below are considered to be part of this specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between the Specification and the Standards referred to herein, the Specification shall govern.

a) Materials

IS: 269 - Specification for ordinary Portland cement.
IS: 383 - Specification for coarse and fine aggregates from natural sources for concrete
IS: 428 - Specification for distemper, oil emulsion, colour as required
IS: 432 - Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement (Parts 1 & 2)
IS: 455 - Specification for Portland slag cement
IS: 458 - Specification for precast concrete pipes (with and without reinforcement)
IS: 650 - Specification for standard sand for testing of cement
IS: 651 - Specification for salt glazed stoneware pipes and fittings
IS: 777 - Specification for glazed earthenware tiles
IS: 808 - Specification for dimensions for hot rolled steel beam, column channel and angle sections
IS: 814 - Specification for covered electrodes for manual metal arc welding of Carbon and Carbon Manganese steel
IS: 1003 - Specification for timber paneled and glazed shutters (Parts 1 & 2)
IS: 1038 - Specification for steel doors, windows and ventilators
IS: 1077 - Specification for common burnt clay building bricks
IS: 1398 - Specification for packing paper, water proof, bitumen laminated
IS: 1489 - Specification for Portland pozzolana cement (Parts 1 & 2)
IS: 1566 - Specification for hard drawn steel wire fabric for concrete reinforcement
IS: 1580 - Specification for bituminous compounds for water proofing and caulking purposes

IS: 1786 - Specification for high strength deformed steel bars and wires for concrete reinforcement
IS: 1852 - Specification for rolling and cutting tolerances for hot rolled steel products
IS: 1948 - Specification for aluminium doors, windows and ventilators

IS: 1977 - Specification for structural steel (ordinary quality)
IS: 2062 - Specification for steel for general structural purposes
IS: 2140 - Specification for Stranded Galvanized Steel Wire for Fencing
IS: 2185 - Specification for concrete masonry units (Parts 1 & 2)
IS: 2202 - Specification for wooden flush door shutters (Parts 1 & 2)
IS: 2645 - Specification for integral cement water proofing compounds
IS: 2750 - Specification for steel scaffoldings
IS: 2835 - Specification for flat transparent sheet glass
IS: 3384 - Specification for bitumen primer for use in waterproofing and damp proofing
IS: 4021 - Specification for timber door, window and ventilator frames
IS: 4350 - Specification for concrete porous pipes for under drainage
IS: 4351 - Specification for steel door frames
IS: 4990 - Specification for plywood for concrete shuttering work
IS: 9862 - Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and chlorine resisting
IS: 10262 - Recommended guidelines for concrete mix design
IS: 12330 - Specification for sulphate resisting Portland cement
IS: 12709 - Glass fiber reinforced plastics (GRP) pipes, joints and fittings for use for potable water supply

b) Tests

IS: 516 - Method of test for strength of concrete
IS: 1182 - Recommended practice for radiographic examination of fusion - welded butt joints in steel plates
IS: 1199 - Methods of sampling and analysis of concrete
IS: 2386 - Methods of test for aggregates for concrete (Parts 1 to 8)
IS: 2720 - Methods of test for soils (Parts 1 to 39)
IS: 2911 - Code of Practice for design and construction of Pile foundations (Part 4)
IS: 3025 - Methods for sampling and test (physical and chemical) for water and wastewater (Parts 1 to 59)
IS: 3495 - Method of test for burnt clay building bricks (Parts 1 to 4)
IS: 3613 - Acceptance tests for wire flux combination for submerged arc welding
IS: 4020 - Methods of tests for wooden flush doors shutters: Type tests
IS: 4031 - Methods of physical tests for hydraulic cement (Parts 1 to 15)
IS: 5807 - Method of test for clear finishes for wooden furniture (Parts 1 to 6)
IS: 7318 - Approval tests for welders when welding procedure approval is not required (Parts 1 and 2)
IS: 13311 - Methods of Non-destructive testing of Concrete: Part 1 & Part 2

c) Codes of Practice

IS: 456 - Code of practice for plain and reinforced concrete
IS: 783 - Code of practice for laying of concrete pipes
IS: 800 - Code of practice for general construction in steel
IS: 806 - Code of practice for use of steel tubes in general building construction

IS: 816 - Code of practice for use of metal arc welding for general construction in mild steel
IS: 817 - Code of practice for training and testing of metal arc welders
IS: 875 - Code of practice for design loads (other than earthquake) for building structures (Parts 1 to 5)
IS: 1081 - Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators
IS: 1172 - Code of practice for basic requirements for water supply, drainage and sanitation
IS: 1477 - Code of practice for painting of ferrous metals in buildings (Parts 1 & 2)
IS: 1597 - Code of practice for construction of stone masonry (Parts 1 & 2)
IS: 1742 - Code of practice for building drainage
IS: 1893 - Criteria for earthquake resistant design of structures (Part 1)
IS: 1904 - Code of Practice for Design and Construction of Foundation in Soils :General Requirements.
IS: 1948 - Specification of aluminium doors, windows and ventilators
IS: 2065 - Code of practice for water supply in buildings
IS: 2204 - Code of practice for construction of reinforced concrete shell roof
IS: 2210 - Code for design of reinforced concrete shell structures and folded plates
IS: 2212 - Code of practice for brickwork
IS: 2338 - Code of practice for finishing of wood and wood based materials (Parts 1 & 2)
IS: 2394 - Code of practice for application of lime plaster finish
IS: 2395 - Code of practice for painting, concrete, masonry and plaster surfaces (Parts 1 & 2)
IS: 2470 - Code of practice for installation of septic tanks (Parts 1 & 2)
IS: 2502 - Code of practice for bending and fixing of bars for concrete reinforcement
IS: 2571 - Code of practice for laying in-situ cement concrete flooring
IS: 2595 - Code of practice for radiographic testing
IS: 2751 - Recommended practice for welding of mild steel plain and deformed bars for reinforced construction
IS: 2911 - Code of Practice for design and construction of Pile foundations
IS: 2974 - Code of practice for design and construction of machine foundations (Parts 1 to 4)
IS: 3114 - Code of practice for laying of Cast Iron pipes
IS: 3370 - Code of practice for concrete structures for the storage of liquids (Parts 1 to 4)
IS: 3414 - Code of practice for design and installation of joints in buildings
IS: 3558 - Code of practice for use of immersion vibrators for consolidating concrete
IS: 3658 - Code of practice for liquid penetrate flaw detection
IS: 3935 - Code of practice for composite construction
IS: 4000 - Code of practice for High strength bolts in steel structures
IS: 4014 - Code of practice for steel tubular scaffolding (Parts 1 & 2)
IS: 4111 - Code of practice for ancillary structures in sewerage system (Parts 1 to 4)
IS: 4127 - Code of practice for laying of glazed stoneware pipes
IS: 4326 - Code of practice for Earthquake Resistant Design and Construction of Buildings
IS: 4353 - Recommendations for submerged arc welding of mild steel and low alloy steels
IS: 5329 - Code of practice for sanitary pipe work above ground for buildings
IS: 5334 - Code of practice for magnetic particle flaw detection of welds
IS: 5822 - Code of practice for laying of welded steel pipes for water supply
IS: 7215 - Tolerances for fabrication of steel structures
IS: 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels

IS:10005 - SI units and recommendations for the use of their multiples and of certain other units
SP: 16 - Design Aids for Reinforced Concrete to IS 456
SP: 34 - Handbook on Concrete Reinforcement and Detailing
SP: 38 - Handbook of Typified Design of Structures with Steel Roof Trusses

d) Construction Safety

IS: 3696 - Safety code for scaffolds and ladder (Parts 1 & 2)
IS: 3764 - Safety code for Excavation work
IS: 7205 - Safety code for erection of structural steel work

1.20 General Arrangement of Plant

The following general guidelines shall be followed in the preparation of general arrangement of Plant:

- Sufficient room shall be allowed between components of plant and adjacent Plant or fixed structures to permit safe and convenient access for operation and maintenance.

- An area adjacent to all mechanical Plant shall be provided as maintenance lay down area.

- fixed runways , lifting eyes or other means shall be provided to permit the removal of Plant that may be required to be removed during the course of its normal operational life for maintenance or any other purpose.

- areas where leakage is likely to occur whether in normal use or during maintenance shall be provided with covered drainage channels which shall direct spillage either to a suitable plant drain or to a sump from where it can be pumped to plant drain.

1.21 Orientation

The works shall be laid out within the confines of the Site in order to interface to the existing infrastructure of roadways and inlet and outlet pipe work. Underground services requiring to be relocated in order to accommodate the proposed site layout shall, with the approval of the Engineer, be relocated by the Contractor.

1.22 Buildings and Structures

All the building and structure works shall generally comply with the following Employer's Requirements unless otherwise specified elsewhere.

1. All building works shall be of reinforced concrete framework (Concrete Grade of M25 as a minimum).

2. All external walls shall be in solid cement concrete blocks of concrete grade M15 and shall be provided as per IS: 2185 (Latest Revision) and shall be 200 mm thick.

3. All internal partition walls shall be in solid concrete blocks of concrete grade M15 and shall be provided as per IS: 2185 (Latest Revision). All internal walls shall be 200mm thick except for toilets. Toilet partition walls shall be in 100 mm thick solid concrete block.

4. (a) Finishes to concrete liquid retaining structures shall be :

F1 - External surfaces, buried
F2 - External surfaces exposed and up to 300 mm below ground level
F2 - Internal surfaces

(b) Finishes to other concrete structures shall be :

F1 - Buried
F1 - Exposed, where plastering is specified
F2 - Exposed

The type of finishes is explained in "Standard Basic Specifications for Civil and Structural Works" in Chapter 4.

5. All internal masonry surfaces & Ceilings finish shall have 12 mm thick plain faced cement plaster in cement mortar (1:4) with neat cement finish on top. Over this, one coat of primer and two coats of plastic emulsion paint of approved quality and shade shall be provided.

6. All external masonry surfaces and concrete surfaces with rough board finish shall have 20 mm thick sand faced cement plaster in two coats, base coat 12 mm thick in cement mortar 1:4 and finishing coat 8 mm thick in cement mortar 1:4. Waterproofing compound of approved make and quality shall be added to the cement mortar in proportions as specified by the manufacturer.

7. All external surfaces above ground level shall have one coat of primer and two coats of waterproof cement-based paint of approved quality and shade. A coat of silicone water repellent paint shall also be applied thereon.

8. Toilet areas, walls and ceilings, shall have one coat of primer and two coats of plastic emulsion paint.

9. Toilet floor slab shall be filled with brick bat coba (broken bricks in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company.

10. The finished floor level in toilet areas shall be 25 mm below general finished floor level elsewhere in the building.

11. The flooring in operator's room, loading/unloading bay, MCC cum Panel room shall be in 25mm thick Kota stone slab of approved shade and pattern and placed over 20 mm thick base of cement mortar 1:4 to give overall thickness of 45 mm. Half tile skirting shall also be provided in these areas.

12. The flooring in the pumping stations, chlorination building, centrifuge building, workshop, blower room, chemical building, security room, D.G.Room, any other equipment room,etc.., shall be 60mm thick cement flooring with Metallic concrete hardener topping, under layer of 42mm thick cement concrete 1:2:4 (1 cement : 2 coarse : 4 graded stone aggregate 16mm thick nominal size) and top layer of 18mm thick metallic concrete hardener consisting of mix 1:2 (1 cement : 2 stone aggregate 6mm nominal size) by volume & mixed with metallic hardening compound of approved quality @ 3 kg/m^2. Including cement slurry and rounding off edges.

13. Toilet areas shall have 300 mm x 600 mm x 6 mm thick ceramic non slippery tiles placed in cement mortar 1:4 to give an overall thickness of 50 mm. 2100 mm high dado, in 150 mm x 150 mm x 6 mm thick glazed tiles (approved make, shade and pattern) placed in cement mortar 1:3 shall also be provided in these areas.

14. The flooring along with skirting in administration building including PLC and SCADA Room shall be 20 mm thick mirror polished, machine cut granite slab of approved shade and pattern placed in cement mortar (1:4). 150mm high skirting shall be provided in these areas. 750mm wide Granite stone shall be provided for laboratory platforms fixed over double sandwiched support as directed and the edges of granite is to be embedded into the wall.

15. The laboratory shall consist of cupboards/ almirahs/ cabinets made from suitable marine grade waterproof plywood. The floor tiles and dado shall be done with ceramic unglazed vitreous Acid resistant tiles 300mm x 300mm size of approved quality.

16. The toilet facilities shall include at least:

(i) 2 Nos. Water closets with white porcelain Orissa pan minimum 580 mm long with flushing cistern of 10 liters capacity.

(ii) 2 Nos. Urinals of sizes 600 mm x 400 mm x 300 mm flat back type in white porcelain separated by a marble partition of size 680 mm x 300 mm.

(iii) 2 Nos. wash basins of size 510 mm x 400 mm in white porcelain with inlet, outlet and overflow arrangements.

(iv) 2 Nos. mirror of size 400 mm x 600 mm wall mounted type fitted over wash basins.

(v) 2 Nos. plastic liquid soap bottles.

(vi) 2 Nos. Stainless steel towel rails minimum 750 mm long.

(vii) All stopcocks, valves and pilar cocks shall be heavy duty chromium plated brass.

(viii) All fittings such as `P' or `S' traps, floor traps, pipes, down take pipes etc.

(ix) The sewage from toilet blocks shall be led to the wet well of terminal sewage pumping station if present under this contract or to the closest gravity sewer or with soak pit with septic tank with necessary arrangements.

17. All staircases shall have granite non-skid tiles for treads and risers of approved make and shade and half tile skirting set in cement mortar in 1:4 to be provided. All concrete stairs shall have aluminium nosing over 2 mm thick rubber strip of width same as nosing for the full length of the tread. Nosing shall be fixed with countersunk screws.

18. Stairways shall be provided to permit access between different levels within buildings. Staircase shall be minimum 1200mm wide, minimum Tread = 250 mm, maximum Riser = 175 mm and maximum 15 number of steps per flight unless specified otherwise. Staircases in general shall not be steeper than 40°. The maximum vertical run for a single flight of stairs shall be 3.0 M.

19. All roof tops and overhead tanks shall be made accessible with ladder provision. Vertical step ladders fitted with landing point extensions shall be permitted where considered appropriate by the Engineer to access areas not frequently visited. Steel staircases shall be constructed of standard channel stringers with M.S. grating treads 25mm thick with non-skid nosing. Steel Ladders shall be minimum 600mm wide and shall not exceed 6m of straight and shall be painted with epoxy paint. PVC encapsulated Cast Iron rungs or step shall be provided on the inner side walls of all the liquid retaining structures at 300mm spacing.

20. All hand railing shall be provided with Aluminum Extrusion tubes having alloy AA6082 Temper T6 or AA 6063 T6 with an ultimate tensile strength of at least 207 MPa and yield strength of at least 172 MPa. The minimum height of hand railing shall be 1m and maximum spacing of verticals shall be 1.5 m (32NB)- Number of horizontal rails shall be 3 (1 top-32 NB, 1 intermediate- 25NB and 1 bottom- 25NB) with a 100 x 2.5 toe plate at the bottom.

21. The reinforced concrete roofs shall be made waterproof by application of an approved roof polythene / bitumen membrane brick bat coba/ Yelahanka tiles. The finished roof surface shall have adequate slope to drain quickly the rain water to R.W down take inlet points.

22. All roof floors shall have minimum 750 mm height solid concrete block parapet wall where accessible is provided and shall have minimum 300 mm height solid concrete block parapet wall where accessible is not provided.

23. For roofing drainage, uPVC 6kg/sqm rainwater down takes with Bell mouth and uPVC grating at top shall be provided. For roof areas up to 40 sqm minimum two nos. 110 mm diameter down take pipes shall be provided. For every additional area of 40 sqm or part thereof, at least one no. 110 mm dia. down take pipe shall be provided.

24. Top surfaces of chajjas and canopies shall be made waterproof by providing a screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rain water. All chajjas and canopies shall be provided with drip moulding.

25. Building plinth shall be minimum 500 mm above average finished ground level around building. Damp proof course shall be minimum 75mm thick in cc 1:3:6.

26. All doors, windows, rolling shutters shall have lintels above. Chajja protection to lintels on external walls shall be such as to prevent the rain water splashing into the building. Chajja projection of minimum 750 mm for rolling shutters, 600 mm for doors and 600 mm for windows shall be provided to prevent the rain water splashing into the building. Chajja shall be projected 150 mm on either side from size of doors/windows/rolling shutters.

27. All windows and ventilators shall have 25 mm thick Bull nosed Granite stone sills bedded in cement mortar (1:3).

28. All doors, windows and ventilators shall be made of aluminium confirming to latest version of IS: 1948. All fixtures for doors, windows and ventilators shall also be of aluminium and shall be provided as per IS specifications. Aluminium grills shall be provided in all the windows. Doors shall be in two panel and both panels shall be glazed/unglazed. Minimum weight of aluminium doors & windows shall be as follows:

I. Single Glazed Window: (Weights indicated shall be aluminium)

a) Openable

Outer Frame	:	Weight 0.70 kg/Rmt
Shutter Frame	:	Weight 0.97 kg/Rmt
Intermediate Mullion	:	Weight 0.97 kg/Rmt
Beading	:	Weight 0.31 kg/Rmt

Fixing Louvers windows/ventilators

Outer Frame	:	Weight 0.46 kg/Rmt

II. Double Glazed Window

Outer Frame	:	Weight 0.72 kg/Rmt
Shutter Frame	:	Weight 0.97 kg/Rmt
Intermediate Mullion	:	Weight 0.98 kg/Rmt
Beading	:	Weight 0.31 kg/Rmt

III. Sliding Windows

Bottom & Top Frame	:	Weight 0.70 kg/m
Shutter Frame	:	Weight 0.42 kg/m
Interlocking Section	:	Weight 0.47 kg/m

IV. Aluminium Door

Outer Frame	:	Weight 2.508 kg/Rmt
Shutter Frame	:	Weight 2.508 kg/Rmt
Bottom Stile	:	Weight 2.508 kg/Rmt

Glazing shall be 5.5wired mm thick glass.as per IS: 2835 for doors and windows.
Glass louvers shall be provided for ventilators with frame weight of 0.46kg/Rmt

29. Openings of the windows & ventilators shall be minimum 25% of the external wall area.

30. Ventilator shall also be provided where height of floor is more than 3m.

31. All windows and ventilators shall have wire mesh. Frame of doors, windows and ventilators shall be of aluminium of standard rolled section. Doors, Windows and Ventilators shall be of size as per schedule to be submitted by the Contractor for approval of Engineer. The minimum size shall be as per below:
Door of opening size 1.2m x 2.1m
Door of opening size 0.75m x 2.1m for toilets
Glazed windows of minimum size 1.2m x 1.2m
Ventilators of minimum size 0.6m x 0.6m

32. Rolling shutters shall be made of 80 x 1.25 mm MS laths. Rolling shutter shall be of minimum size 3m wide x 3.0m high. Rolling shutter shall be provided in MCC cum panel room, chlorine tonner shed, and centrifuge at entry and exit of the pump house for access to pumps, motors, valves, panels, blowers and as wherever required. Up to 3m height mechanical operated rolling shutter shall be provided and If the height is more than 3m, then electrically operated rolling shutter shall be provided.

33. All structural steel members shall be painted with two coats of enamel paint over one shop and one field coat of red oxide zinc chrome primer. All concrete channels and ducts used for conveying liquid shall have inside finish of type F2. The width of concrete channels shall not be less than 500 mm. All open channels shall be provided with Aluminium hand railings.

34. All exposed surface of inserts embedded in concrete shall be painted with two coats of enamel paint over one coat of Red Oxide Zinc Chrome Primer. Surface in contact with concrete shall not be painted.

35. Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factory Act. It shall not be less than 150mm.

36. All structures in the Treatment plant units shall be provided with appropriate sign boards indicating the function of the units involved written in Kannada and English Languages.

37. Wherever equipment and machinery are to be moved for inspection, servicing, replacement etc., suitable movable gantry of minimum capacity of 2 tonnes or more as required shall be provided with monorail and operating equipment.

38. The design of buildings shall reflect the climatic conditions existing on site. Process buildings shall as far as is possible permit the entry of natural light, and the use of glazed panelling shall be kept to a minimum and preference given to wall openings protected by weather canopies.

39. Emergency exit doorways shall be provided from all buildings in order to comply with local and international regulations. Stairways and paved areas shall be provided at the exit points.

40. Toilet blocks in process buildings and control blocks shall be provided with a sink with two drinking water taps of 20 mm size with adequate inlet and outlet connections.

41. The side walls of buildings shall, except those used for storage and handling of Chlorine gas comprise at least 15% ventilated brickwork or louvers. Ventilated brickwork or louvers shall not be used where the ingress of driven rain could affect plant or stored materials. Flat roofed areas shall be provided with roof vents to further encourage a through flow of air.

42. All the walkways shall have minimum 1.0 m width and shall be secured with Aluminium Handrails and toe guards.

43. Suitable River flow training systems/Flow diversion to be adopted at required locations/places in compliance with relevant Geotechnical Investigation Report recommendations as applicable.

44. All concrete structures in contact with sewage and/or sludge shall be provided with full interior corrosion protection linings and/or coatings of appropriate material and thickness to be approved by Employer. For Aeration Basins, interior lining shall extend from the top of wall down to 1.0 meter below the lowest operating water level.

45. For structures containing water or process liquid, the top of the wall shall be at least 0.5m higher than the maximum water surface level calculated at high flood level and peak plant flow. The top level of internal plant roads and approaches shall be at least 1.0 m above the site High Flood Level.

46. If the High flood level is more than Ground Level, then road shall be constructed on the Earthen Embankments/Engineered Embankment. Earthen Embankments/ Engineered Embankment shall be constructed with side slope of at least 2 horizontal to 1 vertical. Stone pitching shall be provided at both sides of the embankment as per IS: 8237. Top width of embankment shall be taken as 6.0m. Top level of embankment shall be 1.0 m above high flood level. The excavated earth from the plant can be used for earthern embankment construction if suitable and if required extra earth can be borrowed from the borrow pit as approved by Engineer.

47. Anti-termite treatment, under and around the column pits, walls, trenches, basement excavation, top surface of the plinth filling, junction of wall and floor, along the external perimeter of building, expansion joints, over the top surface of consolidated earth on which apron is to be laid, surrounding of pipes & conduits, with chloropyriphos emulsifiable concentrates of 20% concentration is to be provided for this only plinth area of the building at ground floor only shall be measured.

48. Engineered Embankment for plant structure in Swampy/Water logged areas shall be considering in compliance with relevant Geotechnical Investigation Report recommendations as applicable.

49. All requirements for Engineered Embankment and all other associated works connected to this system (i.e. all controlled filling requirements, type & suitability of materials, methodologies testing, protective system, aprons, proper slopes, stability, specifications, quality control, and all other requirements pertaining to this system of works, etc.,) shall be considered in compliance with relevant geotechnical investigation report recommendation as applicable. Also, to enlist the service of an experience and specialized agency for all related design aspect consideration, equipment specifications, and implementation methodology, etc., as an advice for the same.

50. MS Chequered plates are not allowed in this contract. Only Aluminium chequered plates of alloy 3105 shall be used wherever necessary. It shall be of minimum 6mm thick and shall be supported with suitable PVC encapsulated MS structural members to handle the loads above the plates. Equipment load above the chequered plates shall be considered as 10KN/Sq m. The fixtures used shall be of SS. The Aluminium plates shall be in accordance with IS737.

1.23 Roadways, Pathways & Hard standings

A comprehensive network of roadways with turning bays as required for access, removal of plant and equipment, removal of sludge, grit etc. From site shall be provided around the treatment plant to link in with the existing road network and permit access to the plant for necessary maintenance, delivery of consumables and personnel access.

All roads shall be designed and constructed as per the specifications and as per site requirements. Bidder shall provide minimum 3.5 m wide internal roads with 1.50m shoulder on one side, which shall be utilised for future expansion of the internal road and 5.0 m wide approach road shall be provided until STP Entry gate from the nearby Main Road or Highway. 1.5 m shoulder on both sides of the road shall be provided as per site requirement and as directed.

The road works shall be designed and constructed as per MORTH guidelines and specifications. The minimum road layers shall consist of granular sub base, sub grade, wet mix macadam (2 layers with compacted thickness of 150 mm), semi dense bituminous concrete, bituminous macadam and Bituminous concrete as per the design requirements All roads shall be provided with drainage and shall be constructed to prevent standing water.

Paved pedestrian access ways shall be constructed to provide a network of logical routes interlinking plant areas. Damage to any existing roads on account of their use by the Contractor shall be made good to the satisfaction of the Engineer.

Hard standing areas with shading facility shall be provided to permit the parking of vehicles involved in the delivery of consumables from blocking site roadways during unloading or loading. The road system shall be designed such that vehicles involved in the delivery of consumables can follow a continuous route through the works and out again without the need to reverse or carryout complicated maneuvers in order to exit the site.

1.24 Site Drainage

The Contractor shall provide a site drainage system. The system shall comprise of the following:

- Storm Water Drainage
- Foul Drainage
- Process Drainage

1.24.1 Storm Water Drainage

For the major storm water drains passing besides or within the STP complex shall be designed as per CPHEEO requirements considering the contributing catchment area. Necessary cross drainage works shall be provided for road crossing etc. If the existing storm water drain is passing through the center of the STP area, the storm water drainage alignment shall be diverted along the edge of the STP complex area for proper usage of the STP area.

For the internal storm water drains adjacent to the existing and proposed roads (under the contract) shall be sized for a rainfall intensity of 50 mm/hr, allowing for 100% run off. The drains adjacent to roads for walls and floor shall be in RCC M 20 grade. The floor is to be laid over a minimum thickness of 10 cm thick 1:3:6 PCC bed and the drain is to be covered with M 25 grade RCC slab. The minimum width of the drain shall be 300 mm. The storm water drainage system shall also be designed to cater the run off from the existing plot areas and structures, if necessary depending upon the site topography.

1.24.2 Foul Drainage

The foul drainage system shall accept discharge from toilets, washrooms, offices and the laboratory. The foul drainage system shall discharge to a septic tank of appropriate volume or to the existing foul drainage system.

1.25 Flood Protection Works

An Earthen Embankment with minimum slope of at least 2 horizontal to 1 vertical on both sides has to be constructed as required. Slope of the embankment shall be decided as per the soil properties. Stone pitching shall be provided on the both the sides of the embankment as per IS: 8237. Top width of the embankment shall be at least 3.5m. Top level of the embankment shall be 587.5. Embankment shall be designed as per IS: 12094.

Earth for the embankment & site grading shall be made available from the contract package of the same project. Excavated earth from Reservoir and pumping station proposed to be constructed as per the contract shall be used for the construction of earthen embankment and site grading. If required, excavated earth from treatment plant shall also be used for earthen embankment and site grading. The embankment shall be constructed with the available material as per the standard specification.

GI chain link fencing shall be 2.75 m high above finished ground level with top 0.75 metre of barbed wire confirming to IS 278. The fencing shall include fabric mesh confirming to IS 2721, top and bottom runner wires, vertical posts, GI strap at every vertical post, etc, all as approved by the Engineer.

1.26 Cable and Pipe work Trenches

Cable and pipe work trenches shall generally be constructed in reinforced concrete.

Trenches within the buildings or Plant areas shall be covered with M20 precast R.C.C covers. The trenches shall be suitably sloped to drain rain water. All uncovered openings shall be protected with hand railing

Layout of trenches outside the buildings shall allow space for construction of future trenches where necessary with due consideration for planning for future developments. This aspect shall be brought to the notice of the Engineer while planning the works.

1.27 Pipes and Ducts

R.C.C ducts for drainage shall have minimum 1 meter over precast cover (M20 concrete, Heavy duty) while laid under roads. Access shafts of size not less than 600 mm x 1000 mm shall be provided.

All drains (except storm water drains adjacent to roads) shall be covered with precast RCC slab and designed structurally for appropriate loads.

1.28 Precast Compound Wall and Gate

Compound wall shall consist of RC precast slab panels (M25) with minimum 60m thickness BWSSB logo, RC post at regular intervals including plinth beam as supports for the panels and necessary RC foundation system for the same along with barbed wire stretched between MS angles fixing at the top of the precast panels with necessary fixtures etc.,

All structural designs and Specifications shall confirm to relevant codal provisions.

An Indicative Typical Boundary wall profile of TYPE-I & TYPE-II is enclosed as reference for the same. (Refer to Sketch -1, appended in Page 32 & 33)

Sewage Treatment plant shall have one main gate to access the plant irrespective of existing gate at the premises of existing plant site. Minimum clear width of main gate shall be 6m. Main gate shall have 1.5m wide wicket gate. Gates shall have as external framework of GI pipes and internal framework of MS flats. Gate shall be fixed on RCC columns. The design and pattern of gate with drawing shall be submitted for approval of the Engineer. The gate shall have all necessary hinges, locking arrangement, rolling arrangement and painting complete, as approved by the Engineer.

1.29 Retaining wall

1. Retaining wall shall be RCC with minimum M25 grade of concrete. Wall foundation shall be placed on virgin soil and not on backfill soil. Foundation shall extend to a depth of at least 1.0 meter below finished ground level or as required

2. Expansion joints shall be provided in the retaining wall.

3. In retaining walls, 100mm dia weep holes shall be provided at 1m vertically and horizontally. The lowest weep hole shall be about 30cm above the ground level. All weep holes shall be surrounded by loose stones and shall have sufficient fall to drain out the water quickly.

1.30 Landscaping

The site shall be landscaped once the Works are substantially complete. Landscaping area shall be marked in layout plan.

Landscaping shall include planting of suitable trees and development of grassed areas. Landscaping in general shall meet ecological and environmental conditions of the site. Road widths shall determine the size of the tree height and spread to be selected for planting. Trees suitable for local conditions shall be selected. Medicinal and fruit trees shall be avoided. Landscaping shall be maintained in good condition till the completion of contract. Area for landscaping shall be equal to total area of project site minus area for the Treatment plant units and the area required for roads, sidewalks and drains.

1.30.1. Tree Planting

Pits dug a few days in advance of actual planting shall be allowed to weather and be filled with top soil mixed with manure. Size of the pit shall be as per standard requirement. Only one tree shall be planted in each pit. A guard made of bamboo with wire mesh or bricks or M.S. rings as approved by Engineer shall be provided. A minimum of 100 trees shall be planted in STP layout or any other suitable location shown by Engineer. A minimum of 20 trees shall be planted in site layout or any other suitable location shown by Engineer. All trees shall be maintained upto the end of O & M period.

1.31 Hydraulic Testing of Liquid Retaining Structure

In addition to the structural test of structures as applicable, the liquid retaining structures shall also be tested for water tightness test at full supply level as described in clauses 12.1,12.1.1, 12.1.2 and 12.1.3 of latest version of IS 3370 (Part I).

On completion of the structure and before its commissioning, the contractor shall carry out a water tightness test for the maximum water head condition i.e. with the water standing at Full Supply Level (FSL) of the structure. This test shall be carried out preferably in dry season in accordance with the procedure given below:

The water tightness test shall be carried out when the construction of liquid retaining structure is completed and when it is possible to fill the structure and ensure that uniform settlement of the structure as a whole or as directed by the Engineer. Before the filling operations are started the structure shall be inspected by the Engineer and the Contractor's Representative and the condition of surfaces of walls, contraction joints shall be noted and it shall be ensured that the jointing material filled in the joint is in position and all openings are closed. The Contractor shall make necessary arrangement for ventilation and lighting of the structure by way of floodlights, circulators etc. for carrying out proper inspection of the surfaces and inner conditions if so desired by the Employer. Records of leakages starting at different levels of water in the reservoir, if any, shall be kept.

The liquid retaining structure once filled shall be allowed to remain so for a period of seven days before any readings of drop in water level are recorded. The level of the water shall be recorded against the subsequent intervals of 24 hours over a period of seven days. The total drop in surface level over a period of seven days shall be taken as an indication of the water tightness of the structure, which for all practical purposes shall not exceed 20 mm excluding evaporation loss. Also there shall be no indications of the leakages around the opening or on the walls.

If the structure does not satisfy the condition of test and the daily drop in water level is decreasing, the period of test may be extended for a further period of seven days and it the specified limit is then reached the structure may be considered as satisfactory.

The external faces of structure shall not show any signs of leakage and shall remain apparently dry over the period of observation of seven days after allowing a seven day period for absorption after filling.

In case the drop in level exceeds the permissible level limit and signs of leakage with the stipulated period of test, the Contractor shall carry out such additional works and adopt such measures as may be directed by the Engineer to reduce the leakage within the permissible limits. The entire rectification work that shall be carried out in this connection shall be at the Contractor's cost. Contractor shall have to make arrangement for filling emptying the structure at his own cost.
If the test results are unsatisfactory, the Contractor shall ascertain the cause and make all necessary repairs and repeat the liquid retaining structures test procedures, at his own cost. Should the re-test results still be unsatisfactory after the repairs, the structure shall be condemned and the Contractor shall dismantle and reconstruct the structure, to the original specification, at his own cost.

During testing and during defect liability period the impression marks created due to seepage shall be rectified and made good.

No separate payment shall be made for water tightness test and the cost thereof shall deem to be covered in the rates quoted for the works.

1.32 Non-Destructive Testing of RCC Structures

Non-Destructive Testing (NDT) shall be carried out as per latest IS: 13311 codes as per the instruction given by Employer.

Commonly used NDT to find quality, structural integrity and soundness of insitu concrete are:

1. Rebound Hammer Test is a qualitative field test method to measure surface hardness of concrete to find insitu concrete strength.

2. Ultrasonic Pulse Velocity (UPV) Test is a qualitative field test method for determination of discontinuities, cracks and depth of cracks of concrete.

3. Core cutting/Sampling Test is a field cum lab test for assessment of strength, density, texture and permeability of concrete.

4. Radiography Test for taking photographs showing details inside of concrete member, where other NDT methods are not suitable.

5. Impact Echo Test is a filed/laboratory test method to detect hidden damage and its extent.

In case there is any distress in concrete during the execution, Engineer can take decision to go for NDT on the RCC construction before taking any action. Contractor shall conduct NDT tests on his own cost.

1.33 Specification for Anti-Corrosive Internal Coating/Lining protection of Concrete Surfaces

Application limits of Anti-Corrosion Internal Coating/Lining for Concrete Surfaces:

1. All units upstream of secondary treatment units shall have to be provided with internal coating/lining for the full internal surface area (Walls and base slab).

2. For the units - Anaerobic Zone, Anoxic Zones, Aeration Zones and Aeration Basin Effluent Channels, internal coating/lining shall be provided on the walls only from the top of the structure to 1.0 m below the lowest operating liquid level

3. For the units handling the solids part such as Sludge Thickener, and all other units, internal lining shall to be provided for the entire internal surface area.

Contractor shall adopt any one of the following materials for internal coating/lining which should be grey coloured, **solvent free**, machine sprayed, resistant to water and chemicals, good bond between concrete surface and lining/coating material and submit his methodology for approval of Engineer. no signs of swelling, scratches or peeling of coating specimen shall be observed after application of coating or lining.

Concrete Structure- Surfaces must be clean, dry and free from curing compounds, laitance, releasing compounds, oil, grease, dirt, chalk, or previously applied coatings. Laitance must, therefore, be removed by sweep blasting or other means prior to coatings application. Ensure that the concrete is sufficiently dry to receive coatings; use a moisture meter. The 6% maximum moisture content shall be permissible. a minimum surface thickness of 500 microns is recommended.

Steel Structures- All surfaces to be coated must be clean and free from dust, grease, oil or loose material. a minimum surface profile of 50- 75 microns is recommended.

Below are some of the vendor products accepted. However, the process and application requirements shall be matched and got approved from the engineer in charge before start of work for the products and vendors mentioned below. Also, if any new material and vendor can meet the process requirements, as stated above, the Engineer in charge shall approve the material specifications by the manufacturer.

Sl No	Approved Vendor	Approved/Appropriate product
1	Sika India Pvt. Ltd.	Intertol Poxitor
2	STP Limited	Shalipoxy – CTE 406
3	BASF Construction chemicals	MasterSeal – 7000CR
4	Fosroc	Nitocote NT402
5	International - PC	Interzone 954

1.34 Rain Water Harvesting System

The Rain water harvesting for the proposed STP complex shall be carried out in line with the regulatory guidelines specified by Bangalore Water Supply and Sewerage Board (BWSSB) & GOK norms.

1.34.1 Components of the Rain water Harvesting scheme

1. Rainwater harvesting carried out for enriching the groundwater resources essentially consist
    a) Common collection tank and
    b) Pipeline(s)

2. Following are the main components proposed for the roof water harvesting system at the STP including their location in the project area:
    a) Rainwater pipes from the roofs of all the building.
    b) First flush piping system.
    c) Storm water drains adjoining the roads of the plant.

1.34.2 Rainwater harvesting system for buildings

The run off from the roof top of all buildings shall be collected to a RCC sump at suitable location in the plan area with a minimum water retaining capacity of 40Cum. The minimum height of the sump shall not be less than 1.8m and 0.3 m free board The runoff shall pass through suitable filters for removal of impurities. A suitable submersible pump shall be provided in the sump for supplying water to gardening and flushing the toilets, to reduce use of potable water.

1.34.3 Rainwater harvesting system for plant area

The runoff from internal road side drain and major plant are shall be drained to rainwater harvesting structures for ground water recharge.

1.35 Well Sinking

The Well Sinking shall be proposed for Wet wells, where the surrounding area is in water logged condition or water table is up to FGL and it is difficult for open foundations. Well Sinking shall be done as per specifications mentioned in Part-10A and shall meet the requirements as mentioned in Part-1, additional scope details for civil works under works –A.

1.36 Gabion

1.36.1 General

A Gabion is a wire cage that can be stacked vertically in a wall and then packed with rough stones and normally used as retaining walls. The Gabions protect slopes and stream banks from the erosive forces of moving water. This bund should keep the construction area dry and free from flood waters. It should be envisaged to provide firm bank protection, for the construction of STP. The requirement of Gabion wall is mentioned in Part-1, additional scope details for civil works under works-A.

1.36.2 Specification

Gabions are compartmented rectangular containers made of heavily galvanised steel wire, filled with stones, the gabion becomes a large, flexible and permeable building block. Gabions comprises of welded wire mesh panels accurately cut to size with heavy section wire spirals used for interconnecting the edges. The meshes and spirals are pre-galvanized with zinc coating of 450 gram per sqm. Gabion shall be confirming to ASTM-A974 (Standard Specifications for Welded Wire Fabric Gabions and Gabion Mattresses).

Gabion shall be provided up to site FGL. Top width of gabion at FGL shall be minimum 1.0m the bottom of the gabion shall be projected minimum 1.0 m below the natural Ground level with 300mm rubble soling below the base as a levelling course. The boulders used in gabion shall be hard and shall not deteriorate under water. The sections shall be worked out considering 10% porosity with a depth of 1m below the ground to the top level and boulder size shall not exceed 200mm.

Stability of the gabion wall under static condition and possible seismic loading shall be ensured for its long-term performance and Stability analysis shall be carried out in accordance with IRC -89 and relevant codes.

1.36.3 Laying Wire Crates and Mattresses

Wire crates shall be made from PVC coated hot dipped galvanized mild steel wire of diameter not less than 4 mm in annealed condition having tensile strength of 300-450 MPa conforming to IS: 280. The galvanizing coating shall be heavy coating for soft condition conforming to IS: 4826. Further for design purposes the contractor shall take into account the requirements of the following BIS codes also –

IS 16013~Welded Wire Gabions (metallic-coated or metallic-coated with PVC coating).

IS 16014~Mechanically woven, double -twisted, hexagonal Wire Mesh Gabions, Rivet Mattresses and Rock fall Netting (Galvanized steel wire or Galvanized steel wore with PVC coating)

The mesh of the crate shall not be more than 150 mm. Where these have to be deposited and there is a chance of overturning, the crate shall be divided into 1.5 m compartments by cross netting.

For deep or inaccessible situations, wire crates can be made smaller subject to the approval of the Engineer. Wire crates built in-situ, shall not be larger than 7.5 m x 3 m x 0.6 m nor smaller than 2 m x 1 m x 0.3 m. Sides of large crates shall be securely stayed at intervals of not more than 1 .50 m to prevent bulging. The Contractor shall design and submit all designs, drawings, method statements, material submittals, Quality Assurance Plans required for the construction of the Gabion structures to the Engineer-in-Charge.

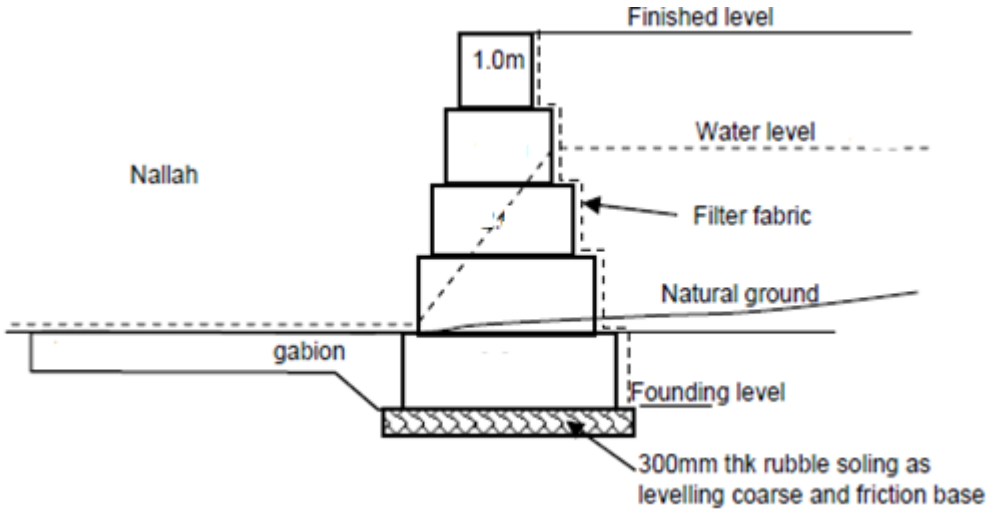


Figure: TYPICAL SECTION OF GABION WALL

1.37 Pile Foundations

1.37.1 General

The design of Pile foundation shall be in accordance with IS: 2911- Bored cast in-situ piles with minimum grade of M30. Where it is anticipated to fill the low lying STP areas to a depth of 2m to 5m (Engineered fill), water logged areas, soft soils, low SBC areas, it is practically difficult to provide shallow foundation, hence pile foundation is proposed in those areas. The requirement of Pile Foundations is mentioned in Part-1, additional scope details for civil works under works-A. Hence the bidder shall follow the same philosophy for pile foundations.

Where site filling is envisaged, In such cases the proposed site shall be filled and compacted up to the FGL with proper consolidation and site filling methodology and later the pile construction activities shall be taken up. Below points are to be taken care

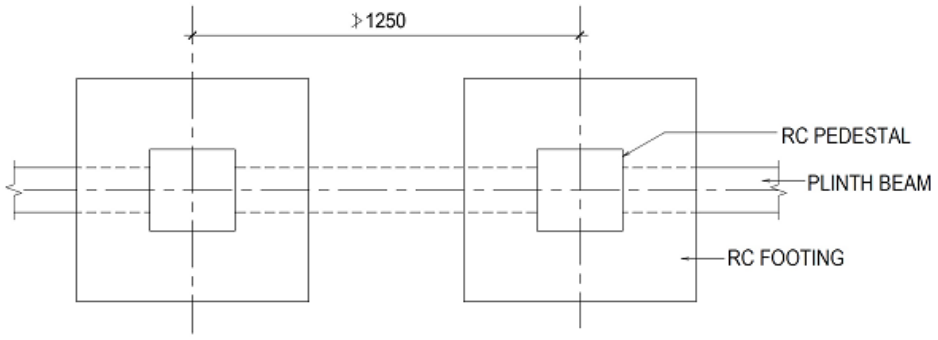
i. Before the actual construction begins, pile load tests must be made to verify the design values, the foundation design must be revised according to the test results.

ii. Piles in sands are driven to the maximum possible depth because pile load is proportional to square of the length. In clayey soils, increased length does not increase the capacity as rapidly as in sandy soils. In clays the length is determined by block failure criterion. Provision of a spread or bulb at the bottom increases the pile load considerably.

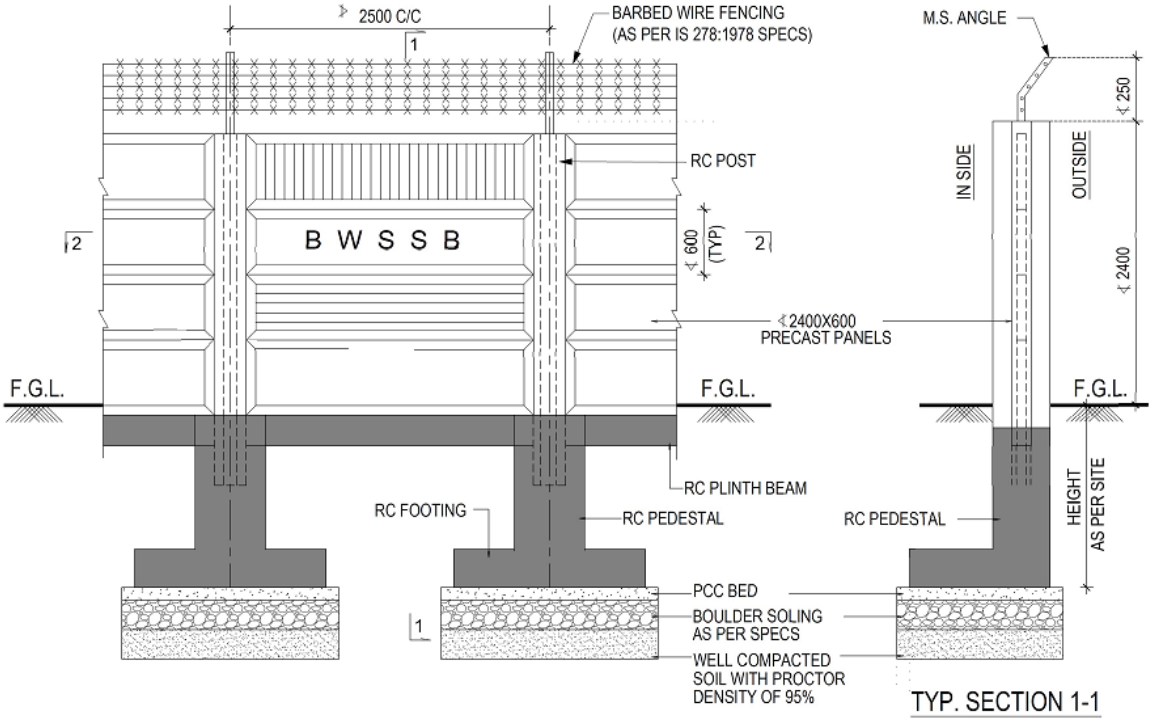
iii. A minimum of three piles are required under a column in order to resist all the column loads and moments acting on it. If one or two piles are provided under a column, the grade beams have to be provided in one or more directions which have to be designed to resist fully column basements since piles shall resist the vertical loads only.

1.37.2 Compaction methodology

The Engineered fill shall be placed in layers of each lift not exceeding 200mm thick with appropriate confinement or self-stabilising slope at the edges. Rollers shall be adopted in order to achieve 97 % modified proctor density, with data for modified proctor density to be initially obtained from laboratory testing of fill material. The number of passes and rollers shall be as suggested in IS-4701(based on soil type). The Quality control tests shall be adopted to verify the achievement of required level of compaction prior to giving clearance for laying next layer. The soil intended for filling shall not have excessive presence of gravels, cobbles/silts and clays.

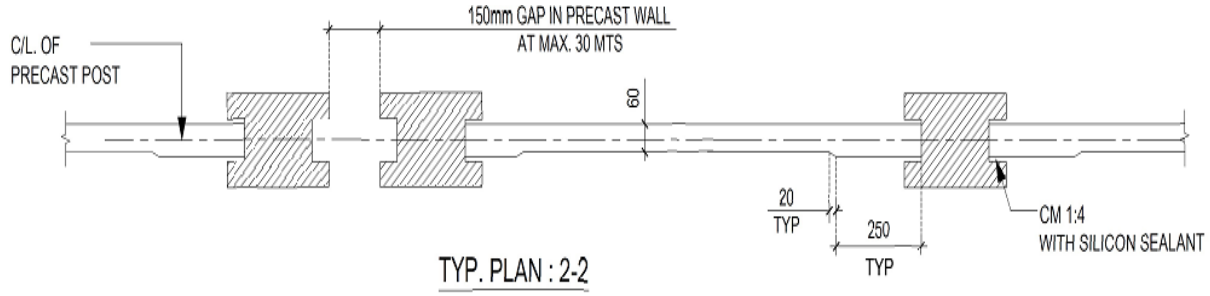


TYP. PART FOUNDATION PLAN



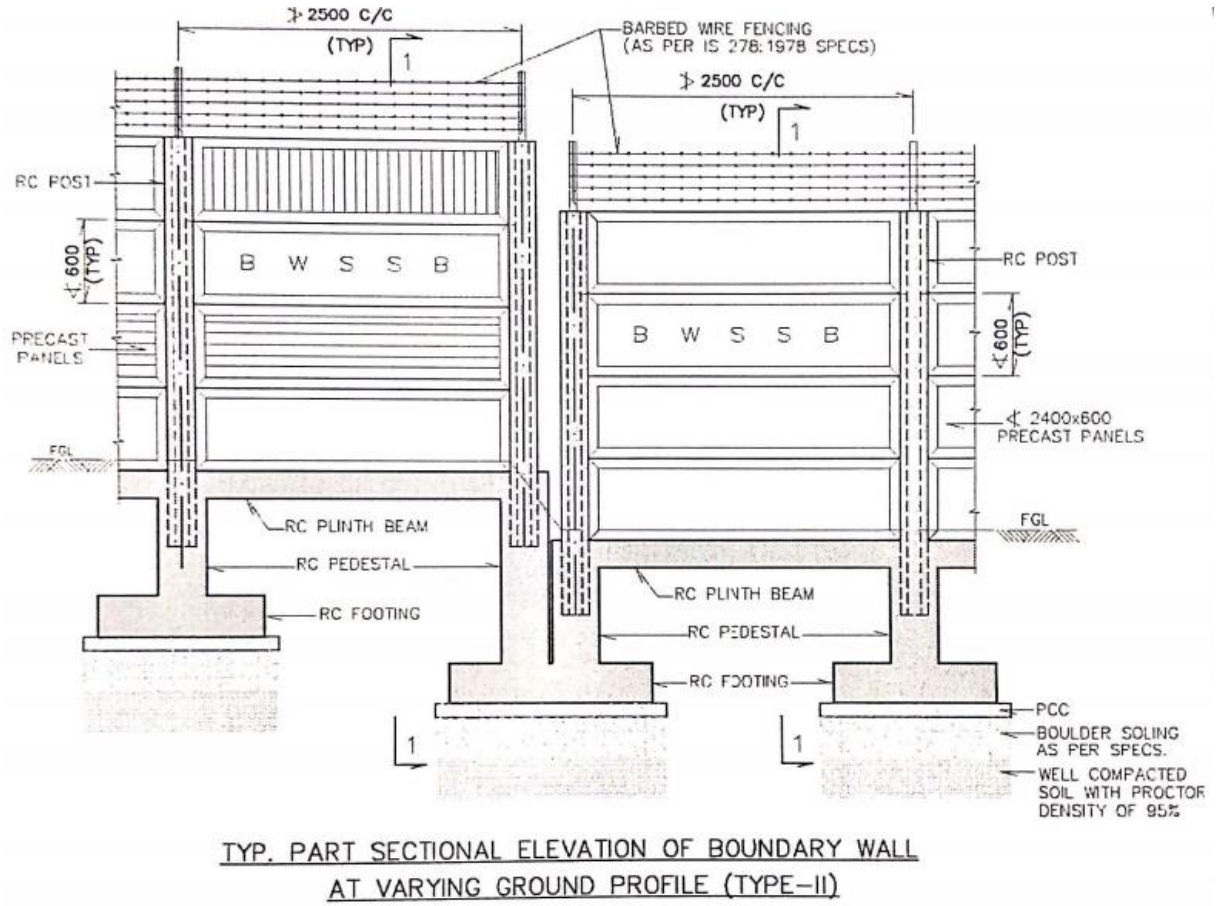
TYP. PART SECTIONAL ELEVATION OF BOUNDARY WALL
AT UNIFORM GROUND PROFILE (TYPE - 1)

TYP. SECTION 1-1



TYP. PLAN : 2-2

SKETCH - 1



TYP. PART SECTIONAL ELEVATION OF BOUNDARY WALL
AT VARYING GROUND PROFILE (TYPE–II)

SKETCH - 2

C. Particular Technical Specifications for Pumping main/Sewer Network and Allied Works

SECTION – 1

EARTHWORK EXCAVATION

1.1 Clearing site of large trees, structures etc.

This shall include the removal of large trees, stumps, structures, services such as cables, water supply, sewerage, storm water drains etc. or parts thereof lying along the alignment of sewer. The contractor should inform the Engineer before removing trees, structures, other services and structures etc. well in advance. Large trees and other valuables are the property of the Government and it should be properly stacked along the side of the road and conveyed to the place as per directions of the departmental Engineer. The cutting of trees or demolitions of structure are done in such a way that it should not disturb the traffic and pedestrians.

1.2 Removal of Top Soil, Shrubs and Other Vegetation

The work has to be tackled in between two adjacent manholes only. All shrubs, vegetation and other plants shall be removed and cleared from the selected stretch of the site. All debris and unsuitable material up to a depth of 30 cm between ground level and road level shall be removed. All debris and unsuitable material shall be carted away from the site as per the direction of departmental engineer. The clearing and grubbing for trees upto 300 mm girth shall be removed. No separate payment shall be paid towards the above works and work includes loading, unloading, carting the material to a site selected by the contractor, disposal of unserviceable materials at his own cost.

1.3 General

Excavation shall be required to be done for the following works:

a) Excavations for underground sewer lines & pumping mains and other works as directed
b) Excavations for sewer lines below storm water drains
c) Excavations for manholes, footings, pedestals and other works as required etc.
d) No separate payment shall be made for removal of shrubs, grass, large and small bushes, trees, stumps and stems of trees cut up to 300 mm girth, fencing including posts and gates and rate for the same shall be deemed to be included in the other pay items of BOQ

1.4 Preparatory Work, Sight-rails and Boning Staves

The centre line of the trench is first marked out on the ground duly driving pegs at convenient intervals. Before commencement of earth work excavation, levels shall be taken along the centre line of the proposed sewer at intervals of say 10 m and at the manhole locations. A longitudinal section (LS) of the profile of the ground surface showing the proposed sewer, indicating the gradients and giving the invert levels of the sewer as well as the manholes available at the tender stage shall be updated based on Contractors re-confirmatory survey and approved by the Engineer before taking up the work.

The width of the trench to be excavated is marked on both sides of the centre line and excavation lines cut out.

Two wooden posts 100 mm x 100 mm x 1800 mm high shall be firmly, erected/fixed across the centre line i.e on either side at nearly equal distance, from the centre line and sufficiently clear of all intended excavation such that the poles/posts are not disturbed during the course of execution of the work.

These posts are so arranged and fixed that a sight-rail when fixed at a level against these posts shall cross the centre line of sewer or centre of the manhole, as the case may be.

The sight-rail made from 250 mm wide x 40 mm thick wooden planks shall be screwed to the poles. The sight-rails shall be truly horizontal. The centre line of the sewer shall be marked on the sight-rail by fixing a nail or otherwise as determined by the Engineer. The sight-rails may be fixed about 1.25 m above the ground, which is convenient distance for sighting by a leveling instrument. The sight-rails have to be so fixed that when a line sighted along the top edge of the sight-rails shall represent the true fall or gradient of the proposed sewer. This gradient is transferred below the ground level by means of boning-rod. Boning is carried out between the sight-rails with the help of a cord or a rope extended from nail to nail fixed on the sight-rails.

Boning rods with cross section 75 x 50 mm of various lengths shall be prepared with wood. Each length shall be a certain number of meters and shall have fixed tee-head. (A cross piece of 450x 100 mm is to be fixed with nails at the top of the boning rod so as to form shape like a Tee-square) and a cross piece about 300 mm long fixed at the bottom of the boning staff. The distance between the top of Tee head and the cross piece shall depend upon the site requirements viz, dia of pipe, depth of cutting, level of sight-rail, designed level of sewer, etc. The boning rod must be marked on two sides to indicate its full length. According to the circumstances of each case, a suitable length of boning rod, duly fixing the cross piece, will be determined upon the reduced level of the invert of pipe at each sight-rail.

The sight-rail and vertical posts shall be perfectly square and planed smooth on all sides and edges. This arrangement of erecting poles with sight-rail shall be done at suitable intervals depending on the site requirements, as directed by the Engineer. The posts and rails must in no case be removed until the trench is excavated, the pipes are laid and permission given to proceed with the filling in.

1.5 Probing Pits

Before starting the excavation of trenches, the contractor shall dig probing pits of size 1 m x 1 m and 1.5 m deep including road cutting at every 100 m interval along the alignment to accurately locate and determine the position of existing utilities and obstructions. The contractor shall refill the probing pits in layers of 15 cm with excavated earth up to the original ground level. In all cases the probing pits are to be excavated in accordance with the specification for excavation, refilling etc. No separate payment will be made for these probing pits and shall be deemed to be included in other pay items of the BOQ.

1.6 Utilities Protection

All utilities within the site, such as water, storm and sewage mains, shall be ascertained by probing pit results at various intervals or as required.
All utility lines and structures, whether indicated on the drawings or not, which are to remain in service shall be protected by the contractor from any damage likely to result from his operations. Any damage to any utility resulting from the contractor's operations shall be repaired at the contractor's expense.

1.7 Pavement Removal

The contractor must inform the Engineer before the starting of work well in advance so that it can be communicated to other concerned departments. The contractor must provide and maintain proper and efficient traffic control system such as safety lamps, sign boards etc. operating day and night for the full duration of work. The BWSSB shall not be responsible under any circumstances for any mishappenings therefore. For the purpose of payment of removal of pavement, steel tapes are to be used and the measurement shall be taken jointly by the Engineer's representative and contractor or his representative.

The maximum width of trench excavation shall as per relevant Indian standards or outer dia of the pipe + 0.3 m whichever is lower and only such widths shall be taken into account for computing quantities for payment. For other elements of work such as manholes, making cross connections, fixing other appurtenances etc. the engineer shall prescribe the dimensions for removal of pavement from time to time.

1.8 Maintenance of Traffic AND Closing of Streets

The work shall be carried out in such a manner which will cause the least interruption to traffic, and the road/street may be closed in such a manner that it causes the least interruption to traffic, Where it is necessary for traffic to cross open trenches, suitable bridges shall be provided. Suitable signs indicating that a street is closed shall be placed and necessary detour signs for the proper maintenance of traffic shall be provided.

1.9 Soil Investigations

Soil analysis reports of proposed sewer alignment are available with BWSSB office. Additional soil tests if necessary shall be carried out along the alignment and the soil boring logs shall be prepared by the contractor at his own cost. Where off-site materials have to be used, the contractor shall, if the Engineer desires make available certified soil test reports including information regarding sieve analysis, plastic limit, liquid limit, maximum density, optimum moisture content etc. from an approved testing laboratory.

1.10 Classification

The excavation work shall be classified into the following categories:

Sewer lines, Manholes, pedestals and other works.

i) All soils: Loamy, clayey soils like BC soils, red earth, ordinary gravels, hard gravel, mixture of gravel and soft disintegrated rock, ordinary gravel, stony earth and earth mixed with boulders of 30 cms size and exclusive of disintegrated rock.

ii) Disintegrated rock, soft rock, soft shale, and medium hard rock comprising of lime stone , sand stone, hard shale schiest, fissured rock or soft rock or conglomerate rock, to be removed by pick axes and crow bars, wedges and hammers with some difficulty including all types of laterite excluding hard rock

iii) Hard rock to be removed only by chiseling and benching/breaker, diamond rope cutting or as directed by the engineer.

1.11 Trench Excavation

General

Trench excavation means excavation of trenches into which the pipe is to be laid. The line and levels of trenches shall be as shown on the drawings or as may be directed by the Engineer. Before commencing trench excavation, the route of the trenches shall be pegged out accurately and the natural ground levels shall be agreed with the Engineer.

1.12 Width of Trench

The width of trenches measured at the crown of the pipe shall permit adequate working space. The trenches shall be widened at sockets and other structures as may be found necessary. The widths to be adopted are shown in respective drawings. If the widths of actual excavation are more than the specified, it has to be made by the contractor with no separate payment. Care should be taken to avoid excessive trench widths and thereby increasing the load on the pipes. The maximum width of trench excavation shall as per relevant Indian standards for pipe laying or outer dia of the pipe + 0.3 m whichever is lower and only such widths shall be taken into account for computing quantities for payment. However, the minimum width of the trench shall be 600 mm.

1.13 Depth of Excavation of Trench

The depths for the trenches will be calculated from the surface to the bed of the pipes and in case when a layer of bedding is to be placed below the pipe line, the depth to the bottom of the bedding will be paid. The depth of excavation for manholes shall be measured from the surface of the existing ground level to the bottom of foundation. No payment will be given beyond this depth.

1.14 Maximum Length of Open Trench

The stretch of work to be tackled shall be limited to two adjacent manholes. However, the Engineer may permit only reasonable trench excavation in advance of the lengths between two adjacent manholes to ensure laying and jointing of pipes can reasonably be expected to be completed and the trench refilled not attended later than 3 days after excavation of the trench. The Contractor will not be permitted to keep trenches open for unduly long periods, creating public hazards. The Engineer's decision in this respect shall be final.

1.15 Trench Sides

Loose boulders shall be removed from the sides of the trenches before allowing workmen into the excavation, and the trench sides shall be stabilized with screening or other methods approved by the Engineer. Trench slopes shall be kept moist where necessary to prevent local sliding as ordered by the Engineer.

1.16 Widening Trench at Joints, etc.

Any widening or deepening of the trench, whether in ordinary soil or rock, necessary to accommodate curves, joints or bends as shown on the drawings or ordered by the Engineer shall be carried out by the contractor.

1.17 Over-excavation of trench bottoms

All excavation carried below the grades shown on drawings, shall be refilled with compacted bedding material at the Contractor's expense.

1.18 Excavated material

The material from the excavation shall be deposited on either side of the trench leaving clear berm on one side at least 40 cm wide or at such further distance from the edges of the trench as may be necessary to prevent the weight of materials from causing the side of the trench to slip or fall, or at such a distance and such a manner as to avoid covering fire-hydrants, sluice valves, manhole covers and the like and so as to avoid any wall or structure or causing inconvenience to the public or other persons or otherwise as the engineer may direct, till it is carted away.

The excavated soil should be so placed and handled as not to inconvenience the usual traffic, till it is carted away. The contractor should also provide necessary bridging over the excavated trenches for the house-holders and pedestrians to cross over and vehicular crossings if and where required at no extra cost, if the Engineer decides that there is no hindrance to traffic due to not carting away the excavated earth, he will give instructions to that effect..

The manhole frames and covers from the existing manholes shall be carefully removed and stored in a suitable place away from the trenches. The contractor should not break the manhole frames and covers while removing. The contractor is responsible for the safety of manhole frames and covers.

1.19 Pipe Bedding

i) Granular Bedding

The bed of trenches shall be prepared as per drawing. Sand used for back fill shall be natural sand (free from cinders, ashes, slag, refuse, organic materials, boulders, rocks or stones) graded from fine to coarse or manufactures sand as per BOQ & contract specifications. The total weight of clay in it shall not exceed 10%. All materials shall pass through a sieve of aperture size 6.30 mm.

ii) Gravel/Murram Bedding

The bed of the trenches shall be prepared as per drawings. The approved granular material shall be of size less than 25mm (murrum) and work shall include watering and consolidation by punners etc., complete with all lead and lifts, as per specification and as directed by the Engineer complete

iii) Stone dust or quarry dust Bedding

The bed of the trenches shall be prepared as per drawings**.** Bedding or Back filling shall be using approved stone dust/quarry dust of size not exceeding 5.6mm for the pipe line trenches and work shall include watering and consolidation to 95% proctor density etc., complete with all lead and lifts as per specification and as directed by the Engineer complete

iv) Concrete Bedding

This type of bedding is as per the drawing appended with the tender document, and is to be provided at locations shown in drawings or as specified by the Engineer. A concrete bedding as per BOQ provisions shall be provided mostly in weak strata and in storm water drains. The concrete work related to this specification is detailed in the specifications of concrete and allied works.

In case of sewers laying in storm water channels, the pipe shall be encased with cement concrete/reinforced cement concrete of grade as per BOQ provision with a minimum thickness of 150 mm all around or as per bedding drawing. If the clear distance between drain bed and pipe top is more than one meter then concrete bedding as directed by the Engineer shall be done.

1.20 Trench excavation in hard rock

If any material which in the opinion of the Contractor can be classified as hard rock is encountered, he shall immediately inform the Engineer and the level, extent and description of the material encountered shall be measured jointly and recorded before excavation.

Only such proportion of material notified and measured which is certified by the Engineer as "rock", shall be paid for as rock excavation.

Excavation for trenches in rock shall be so carried out such that the clearance between the pipe, when laid in position and the sides and trench bottom shall be kept to the minimum limits necessary to provide for specified thickness of bedding, and surround to the pipe as specified. Excavation outside the specified limits shall not be paid for and any additional expenses incurred in providing additional strength to the pipe to overcome the increased trench loads on account of increased width shall be at the Contractor's expenses. The rock thus excavated shall be auctioned as directed by Employer/Engineer as per GOK procedures and the auctioned amount shall be remitted to the Employer/Engineer.

1.21 Excavation for appurtenances

Excavation in trenches for foundation anchor blocks, pedestals etc. shall be as per the plan or as directed by the Engineer. The dimensions of the excavation shall be measured as the projection in plan of the outermost edges of the structure.

1.22 Pumping sewage or diversion by gravity and dewatering

General
The works included in this Section are as follows:

1) Provision of all labour, equipment, materials etc. to ensure a safe and dewatered condition in all areas in which the work in this contract are to be executed.
2) Continuous operation of the dewatering systems is required to complete all portions of the works where dewatering and pumping of sewage is necessary to prevent inflow, collection of surface water or ground water, or sewage or to protect adjacent properties or constructions from damage resulting from a rise or fall of ground water levels or sewage.
3) Removal of the equipment when no longer required.

1.23 Pumping out water and dewatering

The Contractor shall provide and work at his own cost, all pumps, engines and machinery requisite to keep the trenches for the sewers or foundations and all other excavations clear of water, whether sub-soil water, storm water, sewage, leakage from tanks, wells, drains, sewers, water mains or pipes etc., so that there may be no accumulations of such water and that no setting out may be done, no masonry may be laid, no concrete deposited, no joints made and no measurements taken in water.

The pumping shall be continued so long after execution of any portion of the work and repeated so after as the Engineer may consider necessary. The pumps and power applied must be such as the Engineer may consider necessary for the work to set. The pumps and power applied must be such as the Engineer may determine to be sufficient to any particular time so that he may stop the work altogether until he is satisfied and also impose a fine upon the contractor

The Contractor shall be responsible for the adequate pumping, drainage and bailing out of water from the excavation with all rates of recuperations. Dewatering shall be either continuous or intermittent using method approved by the Engineer. The method of dewatering shall depend on site condition should be furnished by the Contractor and approved by the Engineer. The method of dewatering shall be either sump pumping or well point dewatering. The effectiveness of each method will depend upon the nature of the soil, the proportions of the trench and degree of lowering required. Pumping test may be necessary to determine which method is suitable. If sump pumping is not practicable other control methods shall be considered and should be approved by the Engineer. The trenches should be kept

dry till the completion of work, which includes excavation, pipeline laying, jointing, testing and commissioning and backfilling. Precaution should be taken against the flotation of the pipes. The Contractor shall conduct ground studies if found necessary and the cost for such studies have to borne by the Contractor himself.

The Contractor shall be responsible for the adequate pumping, drainage and bailing out of water met due to all causes from the excavation for laying sewer pipe lines and all types of constructions. In case of failure to make such provisions or any other provisions, which may result in unsuitable sub-grade conditions, the Contractor shall replace and repair the sub-grade as directed to the satisfaction of the Engineer, at his own cost and responsibility.

Should the Contractor select to use a gravel sub-grade with or without unjointed pipes with the gravel layers to facilitate flow of water to pumps or other points of disposal, such gravel sub grade with or without conveying pipes shall not be measured or paid as an extra item and rate for the same shall be deemed to be included in the other pay items of BOQ.

1.23.1 Sump pumping

This method may be used in highly and moderately permeable soils such as gravels, sand and gravel mixtures. This method is simple and cheap to install and used with watertight trench sheeting to limit the volume of flow. To prevent the boiling in the bottom of the trench the following precaution should be taken.
Drive sheeting deeper to lengthen drainage path;
Use open pipe surrounded in gravel as a sump;
Move the sump to one side of the trench;
To prevent removal of fines from soil causing loss of strength in the soil and undermining of the trench bottom and side support, surround suction inlet with protected graded filter;
Increase flow rate through the soil by using open pipe surrounded with gravel.

The delivery side of the pump should be monitored by taking samples of water and checking the proportion of fines being removed. If fines are being continuously withdrawn or there are signs of trench instability, sump pumping should be stopped and alternative methods to the considered.

1.23.2 Well pointing

In this method well points are installed at regular intervals on one or both sides of the trench and linked parallel to a header main connected to a pump. Well points are usually installed at 0.6 to 2.0m centre to centre by jetting them in. In ground with dense layers or cobbles & boulders it may be necessary to pre bore the layers. The efficiency of the well points is increased by sanding in the well point and riser using a column of sharp sand. This method has an advantage of drawing water away from the trench and in suitable conditions is effective in lowering the water by 4 to 6m below excavation level. It will also reduce the hydrostatic heads on the trench support system. Its greatest use in sand, the heavy flows impermeable ground, such as gravels, means that the well points have to be so close together that the method becomes impractical. In clays the rate of seepage is too small for the system to be properly effective. Silts can be stabilized in certain conditions by using special procedures.

The well pointing shall be either single sided well point or double sided well point. For higher depths double sided well point with multi stage shall be considered. Should the Contractor select to use a gravel sub-grade to facilitate flow of water to pumps or other points of disposal, such gravel sub-grade shall not be measured or paid for as an extra item. Contractor should assess the availability of extra earth required for refilling in case of shortage in any particular reach well before quoting rates.

Even in case the Contractor resorts to mechanical excavation, the Contractor should take care of proper refilling, consolidation and disposal of surplus earth.

Disposal of ground water is to be away from the area of influence of the pipe laying area Suitable temporary pipelines are to be laid to existing watercourses. For lowering the sub soil water level for the construction of wet wells the bores have to be installed/jetted at distance between two bores varying from 0.6 to 1.0m depending upon sub strata and the incoming flow of water. The bore should be installed at least 1.0m away from the periphery of the excavated earth. The dewatering includes removal of ground water, springs, seepage water, sullage, sewage, running water, rain water etc., in order to make the trench for pipe line works etc. It is to be noted that contractor can adopt the suitable type of dewatering the keep the trench dry until completion of all sewer laying and testing works.

1.24 Keep excavation clear of water

Where ground water/Nallah surface flow is encountered or anticipated the contractor shall provide sufficient pumps to handle the ingress of water and must provide and maintain in working order. Standby pumping units are to be made available and employed in the event of mechanical failure. The contractor must also arrange for night and day operation of the pumps wherever necessary to ensure that the work proceeds at all times.

1.25 Barricading, watching, lighting

The parts of the barricading shall be of timber, securely fixed in the ground not more than 2.50 m apart. They shall not be less than 10 cm in diameter and not less than 1.5 m above the surface of the ground. There shall be two rails, one near the top of the posts and the other about 0.50 m above the ground and each shall be of 5 cm to 10 cm in diameter and sufficiently long to run from post to post to which they shall be tied with strong ropes or the work shall be carried out as per BOQ provisions.

The method of projecting rails beyond the posts and tying together where they meet will not be allowed on any account. All along the edges of the excavated trenches, a bund of earth about 1 m high shall be formed when so directed by the Engineer for further protection. Proper provision shall be made for lighting at night and watchmen shall be kept to see that this is properly done and maintained. In addition to the normal lighting arrangements the contractor shall provide, whenever such work is in progress, battery operated blinking lights (6 volts) in the beginning and end of a trench with a view to provide suitable indication to the vehicular traffic. The contractor shall also provide and display special boards printed with fluorescent prints indicating the progress of work along-the road. Further, in all such cases the work may be carried out departmentally at the risk and cost of the contractor. The contractor shall be held responsible for all claims for compensation as a result of accident or injury to person and non-provision of red flags.

The Contractor shall at his own cost provide all notice boards before opening of roads as directed by the Engineer.

Arrangements shall be made by the contractors to direct traffic when work is in progress. No separate payment shall be paid for this item of work.

1.26 Refilling trenches

1) With a view to restrict the length of open trenches, on completion of the pipe, laying operations, refilling of trenches shall be started immediately by the contractor. Pipe laying and testing shall follow closely upon the progress of trench excavation and the contractor shall not be permitted unreasonable excessive lengths of trench excavation to remain open while awaiting testing of the pipe line.

2) The trench shall be filled by borrowed gravel or approved material up to at least 30 cm. above the top of pipe, back filling is to be done keeping at least 90 cm. length of pipe open at the joints, for verification of joints for water tightness during testing.

3) Care shall be taken while back filling, not to injure or disturb the pipe. Filling shall be carried out simultaneously on both the sides of the pipes so that unequal pressure does not occur.

4) Walking or working on the completed pipeline shall not be permitted unless the trench has been filled to a height of at least 30 cm over the top of the pipe except as may be necessary for tamping, etc., during back filling work.

5) Filling-in shall be done in layers not exceeding 150 mm in thickness accompanied by adequate watering, ramming, etc., so as to get good compaction up to 300 mm above the top of the pipe. Above this level, useful excavated earth free from boulders shall be placed in layers of 150 mm, watered and compacted by tamping. Wherever pipe is laid in the storm water channel, total refilling shall be done with borrowed earth or as directed.

6) The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place.

7) Before and during the backfilling of the trench, precautions shall be taken against the floatation of the pipeline due to the entry of large quantities of water into the trench causing an uplift of the empty or the partly filled pipeline.

8) In case of sewers laid in storm water channels, after refilling is done, the bed of the channel to the extent trench width shall be made with cement concrete of grade M15 with a thickness of 150mm as per the site requirement and as directed.

9) Optimum Moisture Content (OMC) test to be carried at trench section and Maximum Dry Density (MDD) test for the refilled soil in trench to confirm the proper compaction up to 95% of maximum dry density.

1.27 Refilling the road surface

After the backfilling is completed, the contractor shall restore the surface of the trench over the pipe to that road surface existing prior to excavation, i.e., either bitumen or cement concrete as the case may be and verified from the adjacent surface. This will be paid as per the Bill of Quantities. The width for the payment of road cutting or restructuring will be only as per the direction of the Engineer. The work of restructuring of road surface either by bitumen or cement concrete shall be as described in chapter Road restoration.

1.28 Subsidence in filling

Should any subsidence take place in the filling at any place of work i.e. at manholes and over pipe trenches and road surface whatsoever during contract, the contractor shall make good the same at his own cost or the engineer may with or without notice to the contactor make good the same in any way and with any material that he may think proper, and at the expense of the contractor. The

engineer may also, if he anticipates the occurrence of any subsidence, take necessary action deemed fit in which case also the expenses therefore shall be charged to the contractor.

1.29 Disposal of excavated materials

Excavated materials shall be used for refilling etc. and surplus earth shall be disposed off to the outskirts of corporation safely with all leads and lift as directed by the engineer. In case of pipe laying work to be carried at the outer periphery of the lakes, the excess material shall be used for filling and embankment formation along the outer periphery of the lakes for laying of the sewer network

1.30 All works to be clear, clean and perfect

The Contractor, after completion of entire work and before seeking settlement of his final bill, shall prove at his expense that the entire line is clear, clean and perfect in the presence of the Engineer or his authorized subordinate. He should provide suitable instruments, appliances etc., and pass them through the pipes and shall show that water passes freely through the entire reach from higher end to lower end. Necessary precautions such as those indicated hereunder may be taken by the Contractor while checking the completed sewer line for its effective functioning, wherever required.

The manholes should be kept open, as required for one hour or as required, prior to the starting of checking operations and should be so kept open during the whole duration of checking operations. This is to be done for allowing the gases to escape, naturally. In order to prevent fire and explosions, .endangering the life, properties, sewers and other utility services due to presence of combustible gases, no lighted match sticks or other similar material should be thrown in the manhole. All necessary safety equipment's, gadgets and sensors shall be used in the restricted working areas.

Meshes should be placed over the opened manholes to prevent pedestrians etc., from falling in. Likewise, caution boards printed in fluorescent letters such as "DANGER MANHOLE IS KEPT OPEN" etc., shall be provided.

1.31 Laying of sewer pipes along the water body

It is to be noted that sub-mains/trunk lines needs to be laid along the edge of tank/water bodies. If permitted, the edge of the tank shall be first filled with earth and later pipe laying work can be taken up and the excess soil shall be used for this purpose.

1.32 Measurement

The measurement of excavation shall be made on quantity basis as per the actual dimensions of the trench excavated limited to the width shown in the drawings or as directed.

a) Trench excavation

The length of the trench excavation shall be measured along the centre line of pipe at various depths stated in the Bill of Quantities, the total length being segregated into stretches according to the various depths of excavation contained in the Bill of Quantities to fall into the specified categories. Within each stretch the depth applicable shall be within the range specified in Bill of Quantities.

The depth of excavation shall be measured from the top of the trench at the centre before excavation upto the bottom of the bedding under the pipe. If no bedding is provided, the measurement shall be to the level of the bottom of the pipe line. The width of the trench shall be measured on the basis of vertical side walls and the specified widths. No additional

payment shall be made for the widening at sockets, specials, hunching or surrounds beyond the dimensions specified.

b) Structures

Measurement for structure excavation shall be made as per the projection in plan of the outermost edges of the, structure as per the plan at the bottom.

c) Rock excavation

The depth of rock excavation measured for payment shall not exceed the corresponding depth in ordinary excavation or as directed by the Engineer.

In all above cases, no payment will be made for additional selected fill, lean concrete, bedding cradling or hunching concrete that may be specified or ordered by the Engineer as a consequence of excavating beyond the limits specified in the contract documents or ordered by the Engineer.

The contractor has to auction/dispose/use himself the excavated hard rock as per GOK guidelines and the revenue generated in this manner will be recovered in his payment at the prevailing rate of Royalty with applicable GST.

d) Disposal of excavated material

All the excavated material shall be carted away with all lead and lift and it includes loading, unloading, transporting with all lead and lift and as per Engineers directions.

SECTION 2

CONCRETE AND ALLIED WORKS

2.0 General

The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise shall conform to the applicable portions of this specification.

The Engineer shall have the right to inspect the source/s of material/s, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer's approval obtained, prior to starting of concrete work. However, this shall not relieve the contractor with any of his responsibilities and all the materials, which do not conform to the specifications, will be rejected. The detailed specifications are provided in Part 10-A, Standard Technical Specifications

SECTION- 3

SEWER APPURTENANCES

3.1 Manholes

The manhole shall be provided with RCC manhole depending upon diameter of sewers and depending upon the alignment of proposed sewer whether it is on road or in Storm Water Drain (SWD)/in STP premises.

The Precast/Cast In-situ RCC are defined with the following conditions.

- RCC Precast manholes –for all depths

- RCC Cast in situ manholes – In storm water drains, for all dia. of pipe and for all depths.

It is intended to Construct RCC precast/Cast in situ manholes for the proposed sewerage system

(i) Location

Manholes shall be constructed at places as shown on relevant drawings and as directed by the Engineer.

(ii) Excavation

Excavation, shoring, dewatering etc. for the pits of manholes shall be done in accordance with specification.

(iii) General

In general, plain and reinforced concrete work for manholes shall be carried out in accordance with the specification and drawing. The RCC Precast/Cast in Situ manholes shall be of minimum RCC M30 grade concrete using sulphate resistant cement.

Construction of RCC manhole chambers of in M30 grade proportion or approved type pre-cast RCC manhole chambers, constructed using form vibrators of standard type, with barricading, danger lighting and using of sight rails and boning rods whenever necessary, shoring and strutting wherever required using sulphate resistant cement, with minimum M30 grade RCC with 20 mm and downgraded jelly, well graded sand and steel of approved quality, minimum 200 mm thick top concrete slab or as per approved drawings, having wall thickness and raft thickness as in approved drawings and with an offset in raft all-round the chamber as in approved drawings, benching concrete with 1:6 slope towards the central drain finished smooth, including fixing and grouting of pipes, including conveying to work spot supply and fixing of SFRC manhole cover and frame (Heavy duty) confirming to IS 12592 with latest amendments, on a bed of CC 1:2:4 supplying and fixing of minimum 3 mm thick encapsulated plastic footsteps (as per IS 10910) on 12 mm dia Grade FE-415 steel bar (as per IS 1786) staggered at 300 mm apart as detailed in technical specifications, including sand & boulder bedding wherever required, disposal of surplus earth, dewatering until completion of works, curing, engraving manhole number with flow direction on the inner cylindrical surface etc complete including cost of reinforcement steel and fabrication charges, shuttering, shoring, keeping the trench dry until completion of works, including cost of transportation and erection of pre cast members from yard to site and also cost and conveyance of all materials, labour complete with all lead and lift. The precast RCC manhole/Cast in situ chambers are for various diameters and depths as per detailed drawings, specifications and direction of the Engineer

The RCC Precast manholes shall be of minimum RCC M30 grade concrete. The manhole shall be constructed using sulphate resistant cement. The rubber seal joints shall be provided in between precast units, rubber gaskets shall be as per IS 5382. The joints shall be sealed with non-shrink grout. Single rubber seal shall be provided in between precast units. All reinforcement bars shall be HYSD CRS bars of grade FE 500 confirming to IS 1786. The non-core opening shall be 100 mm greater than the outer diameter of the pipe. The lifting holes shall be filled with Concrete. It may be noted that single offset joint configuration shall be adopted at the joint. Based the site requirement, direction of the Engineer or at the request of the contractor, contractor can construct cast in-situ manholes in place of precast manholes with contractors approved design and drawings in restricted areas. Provision for house service connection pipes if required shall be provided as per the direction of the Engineer.

The manholes shall be constructed at places shown on the drawings or wherever directed by the Engineer.

(iv) Cement concrete channel

The channel for the manhole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete extended vertically 50mm above and rendered in cement mortar (1:2) of 20 mm thickness and formed to a slope of 1 in 6 towards the channel.

The branch channels also be similarly constructed with respect to the benching but at their junctions with main channel, an appropriate fall, if required suitably rounded off, in the direction of flow in main channel shall be given.

(v) Pipe entering or leaving manhole

Whenever a pipe enters or leaves a manhole, the pipe shall be encased with the concrete all around the pipes covering the joints.

(vii) Rungs / foot steps

Rungs / footsteps shall be provided in all manholes and shall be Manufacture and conforms to the dimensions of IS 5455:1969 are reinforcement encapsulated with PVC. The surface finish shall have 2mm tread on top by ribbing or chequering. These rungs may be 300 mm apart vertically and shall project a minimum of 100 mm beyond the finished surface of the manhole wall. The top rung shall be 450 mm below the manhole cover and the lowest not more than 300 mm above the benching. Rungs shall be tested as per IS and approved before usage.

(viii) Frame and covers

Frame and covers for manholes shall be of required type and dimensions as per the relevant drawings.

Following information shall be clearly marked on each cover.

a. Year of manufacture
b. Identification mark of the purchaser
c. SEWER / SWD
d. Arrow showing direction of flow
e. Name of manufacturer / Trade mark

(xi) Steel Fibre Reinforced Concrete (SFRC) Frame and Cover

Steel Fibre Reinforced Concrete (SFRC) frame and cover shall be as manufactured as per IS 12592. (Latest edition). The contractor to submit the structural design and drawing of frame and cover and get it approved before manufacturing the same.

(xii) Drop Manhole

When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) of main line and the invert level of branch line is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a manhole shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the

higher sewer to the lower one. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the back drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer.

(xiii) Measurement - Manholes

The depth of manhole shall be measure from the top of cover to the invert level of the deepest outgoing sewer from the manhole. The measurement shall be per number basis and as per the actual depth of manhole constructed.

Notes:

If any damage is caused to the other services such as water supply pipeline, sewer, cable/ other utilities etc. during the construction of manholes Contractor shall be held responsible for the same and shall replace the damaged services at his own cost to the full satisfaction of the Engineer.

The interior of manholes shall be cleared of all debris after construction and before testing the same for water tightness by Contractor at his own cost.

Water for testing of manholes along with pipeline shall be arranged by Contractor at his own cost.

3.2 Existing connections

All existing connections which are removed during the uprooting of the existing sewer if any shall be replaced and reconnected with new sewer as per the directions of the Engineer. The replaced new sewer connections shall be properly laid, jointed and connected as per the directions of the Engineer. During the execution work of replacing sewer if the bedding of the connection has been disturbed it shall be replaced with new bedding as per specification contained in the tender document. After making the connection to the sewer, back filling shall be done in layers as directed by the Engineer.

3.3 Ventilation shafts

Ventilation shafts are to be provided for the manholes in SWD or at places as directed b the Engineer. The connecting pipe from manhole to ventilating shaft shall be DI K-9 150 mm diameter. A foundation block of 150mm thick PCC in M15 is provided surrounding the pipe. The vertical shaft should be made of ductile iron and it should be around 6 m high above the ground level and the internal diameter of the shaft should be 150 mm. All the dimensions are to be taken as per tender drawing. The joint of pipes forming the ventilating shaft should be made air tight. The location of the ventilating shaft should be such that it should not cause any nuisance to the vehicular traffic and the movement of pedestrians. The placing of ventilating shaft should be as per the directions of Engineer in charge. The details of fixing the ventilating shafts are provided in the drawing given in the tender document.

3.4 Concrete cradles, haunching, etc.

The concrete cradles shall be constructed in situ by the contractor, indicated in the drawings, in places wherever required as decided by the Engineer.

Precast Concrete Blocks (Anchor blocks)

It is proposed to lay part of the DWC pipes besides/inside storm water drains or in water logged areas. It is intended that the contractor shall dewater/divert and keep the trench dry before laying of the pipes. The contractor shall provide the anchor blocks or uplift arrangements as per the drawings and as directed. The contractor shall provide precast anchor blocks or uplift arrangements as per the BOQ provisions and as per drawings.

SECTION -4

SPECIFICATION FOR SFRC MANHOLE COVERS

4.1 Scope

Contractor's scope includes the design, manufacture, supplying and fixing the FRC manhole frame and covers. The wet concrete mix is subjected to pressure applied through a hydraulic jack through a plunger kept at the top of the wet mix. The FRC manhole covers shall be able to resist 20 tonnes load bearing capacity. The dimensions shall be as per IS:12592. A 25x3 mm thick MS Flat all around the frame is welded to the main reinforcement of the frame so as to get a clear opening of 560 mm diameter. A 18 SWG MS strap all around the cover and lifting arrangement of 12 mm diameter MS bars welded to the main reinforcement are also to be provided for lifting the manhole covers. A coat of epoxy paint shall be applied to the underside and sides of the frame and cover.

4.2 General

a) The quality of materials, method of testing shall be approved by the Engineer.

b) The Engineer shall have the right to inspect the source/s of material/s, the layout and procurement, the equipment, quality control system, testing of material etc. If the Engineer desires the sample of the FRC cover or materials used for the manufacture of FRC covers, test certificate from approved laboratory. Then the contractor shall arrange the same without any extra cost.

4.3 Material

a) Cement

Unless otherwise specified in the specification or called for the engineer, cement shall be ordinary Portland cement as per the relevant IS code. More details are mentioned on the section of concrete under this tender document.

b) Fine aggregates

The details of this have been mentioned in the section concrete and allied works of this tender document.

c) Coarse aggregate

Coarse aggregate for concrete, shall conform to IS:383. This shall consist of crushed stone and shall be clean and free from elongated flaky or laminated pieces, adhering coating, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter, the maximum size of the aggregate shall be 12 mm.

d) Water

Water for use in concrete and curing shall conform to IS:456/1964 and its subsequent amendments.

4.4 Water/cement ratio

The water-cement ratio shall *be 0.40 to 0.45 to* yield a good workability. The workability can be increased by using appropriate admixtures.

4.5 Fiber Reinforcement

The fibers are cut from 0.40 mm dia high tensile steel wires of about 12000 kg/cm2 ultimate stress. The fiber content for the manufacture of FRC covers is of the order 1 to 1.25% by volume of the concrete.

4.6 Design Mix

The vendor shall design the mix design of the concrete which is expected to give a concrete compressive strength as per IS:12592

4.7 Mixing

Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency.

4.8 Placing and Compaction

The reinforcement shall be placed in proper position in steel moulds coated with a thin layer of mould oil. Concrete shall be filled to slightly overfill the moulds and compacted by vibration and struck off level with a trowel.

Use of needle vibrators for compacting the wet concrete mix containing fibres is not recommended since the holes left by the vibrator in the wet mix may not close after its removal owing to interlocking of the fibres with the mix. Compaction by means of shutter or form or table vibrators is recommended. In case of extra heavy duty and heavy duty cover frames, compaction by means of pressure cum-vibration technique may also be employed so as to achieve dense and strong concrete. Clear cover to reinforcement shall be not less than 15 mm. After de-moulding, cover frames shall be protected until they are sufficiently hardened to permit handling without damage.

4.9 Curing

The hardened concrete manhole cover frame shall be placed in a curing water tank or taken to the curing yard where they shall be kept continuously moist for at least 28 days. Frames may be water cured by immersion in water, covering with water saturated material or by a system of perforated pipes. Mechanical sprinklers or any other approved method that will keep covering frames moist during the specified curing period. Steam curing of manhole cover frames may be adopted instead of method specified above provided the requirements of pressure or non pressure steam curing are fulfilled and the manhole cover frames meet the requirements specified in this section.

4.10 Edge Protection and Finishing

The top and inside surface of cover frames shall be smooth. To prevent the top outer edge from possible damages, it shall be protected by 25 mm x 3 mm mild steel flat as part of the frame. Sufficient number of steel connectors shall be welded to the inner surface of the mild steel flat so as to connect it with the frame reinforcement and these shall be embedded in the concrete during casting. Exposed surface of mild steel flat shall be given suitable treatment with anticorrosive paint or coating. Suitable arrangements may be made for fixing the manhole cover frames in position on the manholes by mutual agreement between the manufacturer and the purchaser.

4.11 Physical requirements

4.11.1 General

All the frames shall be sound and free from cracks and other defects which interferes with the proper placing of the units or impair the strength or performance of the units. Minor chippings resulting from the customary methods of handling and transportation shall not be deemed ground for rejection.

1. Dimension

The inside dimensions at top shall match with the corresponding covers so that the maximum clearance at top between the frame and the cover is not more than 5 mm and the top surface of the frame and cover is in level within a tolerance of .± 5 mm.

2. Scale of Sampling - LOT

In a consignment 500 precast concrete manhole cover frames or a part thereof, of the same type and dimensions and belonging to the same batch of manufacturer, shall be grouped together to constitute a lot For ascertaining conformity to the materials in the lot to requirements of this specification, samples shall be tested from each lot separately. The number of cover frames to be selected from the lot shall depend on the size of lot and shall be according to the following table:

Scale of sampling and permissible number of defectives

No. of cover Frames in the Lot Dimensional Requirement

	Sample Size	**Acceptance Number**
Up to 100	10	1
101 to 200	15	1
201 to 300	20	2
301 to 500	30	3

SECTION – 5

RCC SOCKET SPIGOT NON-PRESSURE PIPES

5.1 General

RCC NP3 and RCC NP4 class pipes shall be used as per the requirement. These pipes shall be in accordance with the specifications mentioned in IS:458-2003 and its Amendments. These proposed pipes shall be in accordance with the specifications mentioned in relevant IS and for which no extra cost other than the one which is mentioned in BOQ will be paid.

5.2 Materials

For pre-cast reinforced concrete pipes, materials complying with the requirements given in (i) to (v) shall be used.

a) Cement

Cement used RCC NP3 pipe should be manufactured with Sulphate resistant cement and conforms to IS: 12330-1988

b) Aggregates

Aggregates used for the manufacture of reinforced concrete pipes shall conform to IS:383-1970. The maximum size of aggregate should not exceed one third the thickness of the pipe or 20 mm, whichever is smaller.

c) Reinforcement

Reinforcement used for the manufacture of the reinforced concrete pipes shall be mild steel Grade I or medium tensile steel bars conforming to IS: 432 (Part1):1982 or hard drawn steel wire conforming to IS: 432 (Part 2) or structural steel (standard quality) bars conforming to IC: 2062.

d) Concrete or Mortar

The quality and design mix requirements of concrete (concrete mix, maximum water-cement ratio, minimum cement content, etc) used for the manufacture of reinforced cement concrete pipes and collars shall conform to IS:456-2000 for at least very severe environment exposure condition and shall also be in accordance with Concrete and Allied works Section of Technical Specifications. In case of pipes cast by spinning process, higher cement contents, more fines and higher water-cement ratio may be the need of the process.

The concrete for non-pressure pipes shall have a minimum compressive strength of 35 N/mm2 at 28 days. If mortar is used, it shall have a minimum cement content of 450kg/m^3 and a compressive strength not less than 35 N/mm2 at 28 days.

Compressive strength tests shall be conducted on 15 cm cubes in accordance with the relevant requirements of IS:456-2000 and IS:516-1959.

The manufacturer shall give a certificate indicating the quantity of cement in the concrete mix.

i) Rubber Ring

Rubber ring chords used in pipe Joints shall conform to Type 2 of IS:5382-1985.Rubbers rings shall be tested and approved before usage.

5.3 Design

i. General

Reinforced concrete pipes either spun or vibrated cast shall be designed such that the maximum tensile stress in the circumferential steel due to specified hydrostatic test pressure does not exceed the limit of 125 N/mm^2 in the case of mild steel rods, 140 N/mm^2 in the case of hard-drawn steel wires and high strength deformed steel bars and wires.

The barrel thickness shall be such that under the specified hydrostatic test pressure, the maximum tensile stress in concrete, when considered as effective to take stress along with the tensile reinforcement shall not exceed 1.5 N/mm^2 for non-pressure pipes. The barrel wall thickness shall be as per IS:458-2003.

Longitudinal reinforcement shall be provided to ensure rigidity and correct location of cages (grids) longitudinally and to limit the effects of transverse cracking. Minimum longitudinal reinforcement shall be as given in respective tables of IS:458.

ii. Reinforcement

The reinforcement in the reinforced concrete pipe shall extend throughout the length of the pipe and shall be so designed that it may be readily placed and maintained to designed shape and in the proper position within the pipe mould during the manufacturing process. The circumferential and longitudinal reinforcement shall be adequate to satisfy the requirements specified under (i).

The pitch of circumferential reinforcement shall be not more than the following:

a) 200 mm for pipes of nominal internal diameter 80 to 150 mm,
b) 150 mm for pipes of nominal internal diameter 200 to 350 mm, and
c) 100 mm for pipes of nominal internal diameter 400 mm and above.

The pitch shall also be not less than the maximum size of aggregate plus the diameter of the reinforcement bar used.

The quantity and disposition of steel in pipes may be decided by mutual agreement between the BWSSB and the supplier; however, it shall be proved by calculations and tests that the quality of the pipes conforms to all the requirements specified in the standard. In the absence of calculations and tests, the reinforcement given in the respective tables of IS:458 shall be used as minimum reinforcement.

If so required by the BWSSB, the manufacturer shall give a certificate indicating the details relating to quality, quantity and dispersion of steel in the pipes as well as the clear cover to the steel provided in the pipe.

iii. Ends of Pipes

Dimensions of spigot and socket for rubber ring roll on jointed pipes shall be as given in the respective tables of IS:458. Reinforcement in socket of rubber ring jointed pipes shall be as given in the respective tables of IS:458-2003.

5.4 Manufacture

5.4.1 General

The methods of manufacture shall be such that the form and dimensions of the finished pipe are accurate within the limits specified in this standard. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis.

ii) Concrete mixing

Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour ad consistency, but in no case shall the mixing be done for less than two minutes. Water-cement ratio shall be less than 0.5.

The concrete shall be placed before setting has commenced. It should be ensured that the concrete is not dropped freely so as to cause segregation. The concrete shall be consolidated by spinning. Vibrating, spinning combined with vibrations, or other appropriate mechanical means.

iii) Reinforcement Cages

Reinforcement cages for pipes shall extend throughout the length of pipe barrel. The cages shall consist of spirals or rings and straight of hard-drawn steel wire or mild steel rod and may be circular. Circular cages and longitudinal reinforcement shall be placed symmetrically with respect to the thickness of the pipe wall. The spirals shall end in a complete ring at both the ends of a pipe.

Pipes having barrel thickness **above 100 mm** shall have double reinforcement cage and the amount of steel in the outer cage shall be 75% of the mass of the inner cage whilst the total shall conform to the requirements specified in the relevant tables of IS 458 : 2003. The total longitudinal steel per pipe shall be given in the relevant tables of the standard but the distribution shall be such that the round shape of the cage is not disturbed.

Diagonal reinforcement may be provided in pipes for which the cages are not welded so as to help in binding the cage securely. It shall, however, be ensured that the clear cover for any reinforcement is not below the limits specified in **6.4 of IS 458.** If diagonal reinforcement is provided, it shall be considered as part of process requirement and shall not be counted against the longitudinal reinforcement and spiral reinforcement. Single reinforcement cage shall be located near the inner surface of the pipe with adequate clear cover.

iv) Water Curing

Pipes manufactured in compliance with this standard shall be water cured for a period of not less than 2 weeks in case of pipes made from ordinary Portland Cement or Portland slag cement or Portland Pozzolana cement or hydrophobic Portland cement, and not less than 1 week in case of pipes made from rapid-hardening Portland cement or 53 grade ordinary Portland cement. Pipes may be water-saturated material or by a system of perforated pipes, mechanical sprinklers, porous hose, or by any other approved method that will keep the pipe moist during the specified curing period. In the case of large pipe projecting partly above the water level, the projected portion shall be kept wet by any suitable means.

5.5 Dimensions

The internal diameter, wall thickness, length of pipes, minimum reinforcements and strength test requirements for different classes of pipes shall be as specified in the respective tables of IS 458. The manufacturer shall inform the **BWSSB** of the effective length of spigot and socket that he is able to supply.

Tolerances

The following tolerances shall be permitted:

Sr. No.		Dimensions	Tolerances
i)		Overall Length	: ± 1% of Standard Length.
ii)		Internal Diameters of Pipes	
	a)	Up to end including 300mm	: ± 3 mm
	b)	Over 300mm and up to and including 600mm	: ± 5 mm
	c)	Over 600mm	: ± 10mm
iii)		Barrel Wall Thickness	
	d)	Up to end including 30mm	:+2mm − 1mm
	e)	Over 300mm and up to and including 50mm	: +3mm − 1.5mm
	f)	Over 50mm and up to and including 65mm	:+4mm − 2mm
	g)	Over 65mm and up to and including 80mm	: +5mm − 2.5mm
	h)	Over 80mm and up to and including 95mm	:+6mm − 3mm
	i)	Over 95mm	: +7mm − 3.5mm

Note:

In case of pipes with flexible rubber ring joints, the tolerance on thickness near the ends will have to be reduced. Near the rubber ring joints, the tolerance on thickness shall be as given in Tables 13 to 19 of IS:458.

5.6 Workmanship and finish

i) Finish

Pipes shall be straight and free from cracks except that craze cracks may be permitted The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench, no opening between ends in contact shall exceed 3 mm in pipes up to 600 mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter

The outside and inside surfaces of pipes shall be dense and hard and shall not be coated with cement wash. The inside surface of pipe shall be smooth. For better bond the inner surface of the collar may be finished rough.

The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Pipes shall be free from local dents or bulges greater than 3.0 mm in depth and dents and bulges shall not be extending over a length in any direction greater than twice the thickness of barrel.

Pipes may be repaired, if necessary, because of accidental injury during manufacture of handling and shall be accepted if in the opinion of the BWSSB, the repairs are sound and appropriately finished and cured, and the repaired pipe conforms to the requirements of this specification.

ii) Deviation from Straight

The deviation from straight in any pipe throughout its effective length, tested by means of a rigid straight edge as described in IS 3597 shall not exceed, for all diameters, 3 mm for every meter run.

5.7 Tests, sampling, inspection and marking

All RCC S/S Non-pressure pipes are to be tested, for the numbers/scale of sampling and inspected and clearly marked as per the relevant clauses (10, 11 and 12) in IS:458-2003.

5.8 Transport and handling of pipes and other materials

The specification for transport and handling of pipes shall conform to IS: 783-1985 unless otherwise specified.

a) The R.C.C. pipes, base plates, manhole frames and covers, bolts and nuts, clamps etc., shall be transported by the contractor for laying and construction work at the respective sites of work at his own cost.

b) It is essential to transport, handle and lay the pipes, materials, etc in such a manner as not to cause damage. In lorry/truck shipments, the pipe shall be supported in wide cradles of suitably padded timbers hollowed out on the supporting surface to fit the curvature of pipe, and all chains, calves, or other equipment used for fastening the load shall be carefully padded. For smaller diameter pipes, sand or saw-dust filled bags may be used instead of hollowed out timbers. Pipes shall not be thrown down from the lorries/trucks nor shall that be dragged or rolled along hard surfaces. Slings of canvas or equally nonabrasive materials of suitable width or special attachment shaped to fit the pipe ends shall be used for lifting and lowering pipes so as to eliminate the risk of damage.

c) Great care shall be taken in handling the pipes right from the first operation until they are laid and jointed. The contractor shall be responsible for any loss or damage to the pipes and other materials.

5.9 Permission to lay pipe, concrete

When any portion of the excavation shall have been carried down to the necessary depth, the contractor shall obtain permission from the Engineer before commencing the laying of pipes or concrete.

5.10 Laying and jointing of sewers

a) The specification for laying and jointing of RCC pipes shall conform generally to IS:783-1985 and amendments thereon.

b) These specifications cover the work of laying all RCC pipe lines, underground and above ground, including all civil works required for the same.

c) The Contractor shall manufacture the pipes for a length of maximum 500 m at a time. All these pipes should not be conveyed to the site at a stretch, Contractor shall carefully convey and stack the pipes along the side of the road at every two manhole lengths only. and this should not affect the traffic and pedestrians.

5.11 Laying and Jointing of R.C.C. pipes

a) Before commencing the work of pipe laying the contractor shall study the longitudinal section and other relevant details of the pipe line for the section/reach concerned. Pedestals/ cradles to be provided for shall be constructed before commencing the pipe laying work in any section, If the pipes are required to be wholly encased in concrete encasement of the pipes shall be done as per the method decided by the Engineer.

b) The contractor should check all pipes, rubber rings and other materials beforehand and satisfy himself and intimate, the department if any defects are noticed or if the quality is found to be not to standard.

c) All pipes shall be carefully handled and lowered into the trench by means of proper methods of handling. The pipes shall be handled by flat rubber belts.

d) Socket should face the opposite to the direction of flow. Pipe shall be normally laid so that spigot end enters the socket face. The socket and spigot ends of the pipe shall be cleared of all extraneous matter especially of clay and grease. Rubber ring shall be clean and dry.

e) All the pipes shall be laid perfectly true both in line and grade specified in the drawings. the rubber rings shall be kept evenly positioned on the spigot groove and when satisfied that the pipe and rubber ring are correctly positioned, the pipe shall be forced/pushed well right home of the full depth of the joint by means of uniformly applied pressure with the aid of a jack or similar appliance. The rubber ring shall conform to 1S:5382-1985. Inside the joint, the two pipe ends shall be in close proximity. Properly fitted temporary wooden stoppers shall be provided and constantly used to close the ends of all in completed pipe lines.

f) Bailing or pumping out of water from trench including shoring, strutting and removing slush while laying, jointing and testing shall be done by the contractor. Caving, sliding, under pinning, floatation are some of the features to be kept in view by the contractor and he shall take all required/necessary special precautions during the course of execution. The contractor shall see that water will not be allowed to accumulate in open trenches, where work is in an incomplete stage. Precautionary works such as blank-flanging the open ends of the pipe line shall be taken up at the contractor's account and no separate payment will be made for the same. Should any section of the pipe line float during the contract period, the entire cost of laying it again to the correct line and level shall be to the account of the contractor.

g) Blank flanges
Blank flanges shall be provided at all ends left unattended for the temporary closure of work. At the end of a day's work, also suitable closures shall invariably be provided at the open end or ends to protect the pipe line from ingress of sub-soil water, mud, muck, debris, dust etc.

h) Wherever pipe laying work is done from two faces and/or has to be done in broken stretches due to any difficulty met with at site, to carry out final connection, the contractor should take all special precautions such as maintaining the levels, grades, alignment keeping in view the length of pipes. If any mistake or error occurs, the contractor shall relay the entire stretch at his cost. Any losses or damages either to pipes

or other material thereupon shall be at the contractor's expense and necessary recoveries shall be made.

i) Precautions against floatation

When pipeline laid underground or above ground in a long narrow cutting gets submerged in water collected in the trench or cutting, it is subjected to an uplift pressure due to buoyancy and is likely to float, completely or partly empty. In the design of pipelines, provision is made to safeguard against floatation by providing sufficient overburden or by providing sufficient dead weight by means of anchor blocks.

In the case of the work extending into the monsoon season, however, special care and precautions are necessary during the progress of work on this account. The work of providing anchor blocks and refilling the trenches to the required level and compacting the same etc. shall always be done as soon as the pipeline has been laid.

The contractor shall see that water will not be allowed to accumulate in open trenches, where work is in an incomplete stage, precautionary work such as blank-flanging the open ends of the pipeline and filling the pipeline with water etc. shall be taken as directed by the Engineer. Such works shall be to the contractor's account and no separate payment will be made for the same. A two metres over burden shall be maintained at all times. Where this overburden is not available, anchor blocks have to be provided.

Protection of pipeline against floatation during the contract period shall be the responsibility of contractor. Should any section of the pipe line float due to their negligence etc, the entire cost of laying it again to the correct line and level shall be to his account.

5.12 Spigot and socket joint (flexible)

The RCC pipe with rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The RCC pipe shall be of spigot and socket type and rubber ring shall be used, and manufacturer’s instructions shall be deemed to form a part of these Employer’s Requirements. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

5.13 Cleaning of pipes

As soon as a stretch of RCC pipes has been laid complete from manhole to manhole or fora stretch as directed by Engineer, Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of the pipes. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions the Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by the Engineer.

It shall also be ascertained by contractor that each stretch from manhole to manhole or the stretch as directed by Engineer is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line suitably enlightened by projected sunlight or otherwise.

5.14 Testing at work site

After laying and jointing of RCC pipes is completed the pipe line shall be tested at work site as per the following Employer's Requirements and as directed by the Engineer. All equipment for testing at work site shall be supplied and erected by contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be contractor's responsibility and shall be rectified by him to full satisfaction of the Engineer. Water used for the test shall be removed from pipes and not released to the excavated trenches. The details of testing are given in other sections of this chapter below.

SECTION – 6

DOUBLE WALL CORRUGATED PIPES (DWC PIPES)

6.1 General

DWC pipes shall conform to IS 16098 (Part-2). The pipes shall be with non-smooth external and smooth internal surface based on PE structured wall piping system for non-pressure underground sewerage system.

DWC pipes are classified on ring stiffness and shall be designated in the following nominal ring stiffness classes (SN):

a) DN ≤ 500: SN 4, SN 8 or SN 16

b) DN >500: SN 2, SN 4, SN 8 or SN 16m

Under this contract, it is proposed to adopt Class SN8 ring stiffness as per IS 16098 (Part-2).

6.2 Composition of the material

The material from which the pipe is produced shall consist substantially of polyethylene (PE) or polypropylene (PP) to which may be added those additives that are needed to facilitate the manufacture of the pipes as per Tables 1, 2, 3 and 4 of IS 16098 (Part-2) and conforming to requirements of IS16098 (Part-2). In general, (i) base density shall be ≥ 0.930 g/cc in accordance with IS 7328 (ii) Melt flow rate (MFR) ≤ 1.6 g/10 min at 190 ^{0}C and 5 Kg loading mass and shall be as per IS 2530 (iii) Thermal stability (oxidation induction test at 200 ^{0}C)≥ 20 min.

6.3 Rework material

Clean, reprocess able material generated from a manufacturer's own production according to IS 16098 (Part-2) may be used if it is derived from the same raw material as used for the relevant production. Reprocess able material obtained from external sources and recyclable material shall not be used.

6.4 Wall construction designated as type B

Outside Profiled and Inside Smooth Profile Section: A pipe with a smooth internal and profiled external surface forming a finished double walled profile shall be confirming to IS 16098 (Part-2).

6.5 Dimension of pipes and fittings

Diameter of Pipe

The internal diameter (DN/ID) shall be as per Cl No. 6.3.1, Table 5 of IS 16098 (Part-2).

Length of Pipe

The effective length of pipe shall be not less than that specified in Cl No. 6.3.2 and as given in Fig. 2 of IS 16098 (Part-2).

Diameters of Pipes and Spigots of Pipes

The nominal sizes and minimum mean inside diameter for DN-ID series are specified in Cl No. 6.3.3, Table 5 of IS 16098 (Part-2).

The outside diameters of the DN-ID series pipes and spigots intended to have jointing dimensions as pipes according IS 16098 (Part-2) shall comply with the outside diameters and tolerances as specified by the manufacturer.

Diameters and Jointing Dimensions of Sockets and Spigots

Minimum requirement regarding the socket and spigot dimension are specified in Cl No 6.3.4, Table 5 of IS 16098 (Part-2) and Joints with the elastomeric sealing ring shall be positioned in the socket of pipes.

Wall Thickness of Spigot

When the spigot has the same design as the pipe, the wall thickness requirements for the corresponding pipe dimension and construction shall be as per Cl No. 6.3.5 of IS 16098 (Part-2).

Wall thickness of sockets & spigots and joint design requirements

In addition to the minimum required wall thickness of sockets and spigots as per Cl No. 6.3.5 of IS 16098-(Part-2), their ring stiffness, when determined in accordance with Table 10 of IS-16098 shall conform to the requirements of 6.3.5.1.1 of IS 16098 (Part-2).

6.6 Physical characteristics for pipes and fittings

Appearance

The structured outer layer of finished pipes shall be uniformly corrugated. The inner layer shall be smooth and plain. Both layers shall be free from any visual defects such as cracks, blisters, foreign inclusions and any other visual irregularities which may cause harm to its construction integrities. The inner surface may reflect slight shallow undulations and overall shall be as per Cl No.7.1 of IS 16098 (Part-2).

Colour of Finished Pipes

The inner and outer layer of pipes shall be coloured throughout. The outside layer of pipes and fittings should preferably be black, orange brown or grey and overall shall be as per Cl No.7.1.1 of IS 16098 (Part-2).

Physical Characteristics

When tested in accordance with the test method specified in Table 6 (Physical Characteristics of PE Pipes) using the indicated parameters, the pipes shall have physical characteristics conforming to the requirements given in Table 6 of IS 16098 (Part-2).

6.7 Mechanical characteristics

Mechanical Characteristics of Pipes

The ring stiffness, Impact Strength, Ring flexibility and Creep ratio for the pipes when tested in accordance with the test method specified in Table 10 using the indicated parameters, pipe shall have mechanical characteristics conforming to the requirements given in Table 10 of IS 16098 (Part-2).

Joints

Elastomeric sealing rings used for joining of pipes shall be free from substances that can have a detrimental effect on the pipes. Elastomeric sealing rings shall be in accordance with one of the type (Type 1 to Type 6) of IS 5382 based on the manufacturers recommendation. A test report or conformity certificate shall be provided from the manufacturer of the sealing ring for conformity to IS 5382.

6.8 Performance requirements

When tested in accordance with the test methods specified in Cl No.9, Table 12, for (i) Tightness of Elastomeric ring seal, (ii) water tightness, resistance to internal pressure, (iii) Resistance to combined temperature cycling and external loading and other parameters as per the Cl No.9 of Table 12, the joints and the system shall have characteristics conforming to the requirements given in Table 12 of IS 16098 (Part-2).

6.9 Sampling, frequency of tests and criteria for conformity

Acceptance Test

Acceptance tests are carried out on sample selected from a lot as per IS in accordance with Table 13 (for pipes) of IS 16098 (Part).

Type Test

Type testing shall be in accordance with Tables 15 of IS 16098 (Part-2), as applicable. All tests are required to be carried out either in an in-house laboratory or at an authorized third party laboratory.

Sampling Lot

All pipes of the same size, same grade and manufactured essentially under similar conditions shall constitute a lot. These pipes shall be selected at random from the lot and in order to ensure the randomness of selection, a random number table shall be used as per IS 4905.

In the absence of a random number table, the procedure given in Table 19 of IS 16098 (Part-2) may be adopted.

Conformance

The lot having satisfied dimensional and visual requirements shall be tested for other requirements with the sample size selected as per Table 20 of IS 16098 from the lot for conformance as per IS 16098(Part-2).

6.10 Marking

General Marking shall be labelled, printed or formed directly on the pipe, in such a way that after storage, weathering and handling the legibility shall be maintained.

Minimum Required Marking Pipes

Each pipes shall be marked at intervals of maximum 3 m, at least once per pipe, with the following information: a) Manufacturer's name/Trade-mark; b) Diameter series, nominal size; c) Stiffness class; d) Material; and e) Lot number/batch number containing information regarding period of manufacture (f) Name of the Client : BWSSB, Bengaluru.

BIS Certification Marking Each pipe shall also be marked with the Standard Mark.

6.11 Transportation, handling, installation and jointing

6.11.1 Transportation

The arrangement of loading the pipes in a telescopic manner is advised, that is, smaller diameters inserted into the next higher sizes of pipes up to the height of 2.5 m in a truck. While loading the pipes into the truck, care should be taken that the spigot/coupler end should be arranged alternatively in the corresponding layer so as to avoid the damage to the coupling/socket-end.

6.11.2 Handling

Following recommendations shall be followed while handling the pipes: a) Pipes shall be smoothly lowered to the ground. b) Pipes should not be dragged against the ground to avoid the damages to the coupler/ pipes. c) 900 mm and larger diameter pipes are carried with slings at two points spaced approximately at 3 m apart. d) For smaller diameters (450 mm to 900 mm, both exclusive) one lift point shall be sufficient. e) For diameters smaller than or equal to 450 mm, manual labour can be used. f) Loading boom or fork lift should not be used directly on or inside pipe.

6.11.3 Pipe Storage at Site

Stockpiling shall be done temporarily on a flat clear area as per IS 16098(Part-2). For avoiding collapse of stacks, wooden posts or blocks shall be used. Stacking shall not be higher than 2.5 m. While stacking, alternate the socket/coupler ends at each row of stacked pipes as per IS 16098 (Part-2).

6.12 Construction methods

6.12.1 Trench Preparation

Dimensions: The width of a sewer trench depends on the soil condition, type of side protection and the working space required at the bottom of trench for smooth installations. Increase in width over required minimum would unduly increase the load on pipe and cost of road restoration. Considering all above factors, the minimum trench width is specified as per Table 21 of IS 16098 (Part-2) and given below shall be adopted.

Minimum Trench Widths

(Clause A-4.1.1)

S. No.	Pipe Diameter (in mm)	Trench Width (in M)
1	75 to 200	0.6
2	250	0.7
3	300	0.8
4	400	0.9
5	600	1.2
6	800	1.3
7	900	1.6
8	1000	1.8
9	1200	2.0

6.12.2 Excavation:

Excavation of sewer trenches shall be in straight lines as much as possible and to the correct depths and gradients as specified in drawings.

Excavated spoils shall not be deposited in the near proximity to prevent the collapse of side of the trenches. The sides of the trench shall, however, be supported by shoring (where necessary) to ensure proper and speedy excavations and concurrently ensuring necessary protections to contiguous structures. In the event, the presence of ground water is likely to cause instability in soil conditions, sump pumping/a well point system/any other suitable dewatering system may be adopted for lowering of water table below the requisite trench bed level. If excavation is made deeper than necessary the same shall be filled and compacted at the contractors cost.

6.12.3 Shoring: mild steel sheet piling: As per the site requirement and as directed, the protective shoring works shall be strong enough to prevent caving in of trench walls or subsidence of contagious areas adjacent to trench.

6.12.4 Underground services:

The underground public and private utility services exposed due to the excavation shall be effectively supported under the guidance of the owners of such services.

6.12.5 Dewatering: Sewer installation trenches shall be adequately dewatered for the placement of pipe at proper gradient till the pipe is integrated through socket and spigot joint assembly with the already laid segment.

Precautions are to be taken to arrest floating of installed sewer segments against buoyant forces in case of sudden accumulation of water in the trench. The diameter wise minimum cover necessary to counteract the buoyant forces is given in Table 22.

For exceptional cases of higher level of ground water, additional anchoring at equal intervals would be necessary and shall be done as per the contract provisions.

6.12.6 Bedding: For maintenance of sewer slopes the initial backfill envelop with sand or gravel or as per site requirement and as directed would be sufficient. In the event, anchorage becomes imperative the transverse concrete anchorage blocks spaced at suitable interval shall also act as chairs for defining and maintaining the sewer slopes.

Laying:

a) Make the trench reasonably free from ground water and other liquids.

b) Place the pipe on the top level cross-struts of the timber shoring/mild steel sheet piling frame work.

c) Dismantle one/two cross struts and lower the pipes to the immediate lower layer of the cross struts and re-fix the struts immediately (in case of shoring for supporting the trench sides).

d) In the same above manner, reach up to the initial back filling and place the pipe at proper slope.

e) Ensure anchorage, if any, after laying.

Jointing: Various methods for jointing such as spigot and sockets are used.

The moulded socket will have a suitable internal surface with profiles ribs for insertion of the next pipe into it. The socket end of the pipe to be inserted will have corrugated outer layer. On first valley segment of corrugated pipe (destined to be pushed into the coupler socket) one elastomeric rubber ring needs to be placed which is pushed into the coupler socket. This provides sufficient gripping lock and leak proof joint.

For quality connections following steps are to be ensured, failing which the performance aspects are to be severely compromised: a) The non-coupler-socket end needs to be thoroughly cleared and shall be free from any foreign material. b) Use a clean rag or brush to lubricate the non-coupler socket end with lubricant.

(c) Clean and lubricate the coupler end (spigot) of the pipe to be laid in similar manner. d) Lubricate the exposed gasket in the same manner with pipe lubricant. e) Keep the lubricated non-coupler end free from dirt, backfill material, and foreign matter so that the joint integrity is not compromised. f) Push the coupler/socket into non-coupler/spigot and align properly. Always push coupler end into non-coupler end. For smaller diameter pipes simple manual insertion shall be sufficient. In every methodology, it should be ensured that the coupler end is adequately ‘homed’ within non-coupler end to ensure installation and tight joining seal. Therefore, prior to insertion always place a homing mark on appropriate corrugation of the noncoupler end.

6.12.7 Construction of Backfill Envelope and Backfilling of the Trenches:

These pipes and well compacted backfill envelope work together to support soil and traffic load. In general, material used for construction of backfill envelop around the pipe comprises the following: a) Initial backfill; b) Side fill; and c) Top backfill.

The material for backfill envelop shall be as per the structural design of flexible buried conduit. It can be the same material that were removed in the course of excavation or it can be fine sand/course sand/gravel or as per site requirement and as directed. The remaining portion of backfilling shall be the materials that were removed in the course of excavation. These

materials shall consist of clean earth and shall be free from large clod or stone above 75 mm, ashes, refuse and other injurious materials. After completion of laying of pipes, etc, first the backfill envelope shall be constructed as per design around pipe. Voids must be eliminated by knifing under and around pipe or by some other technique and compacted with necessary watering, either by hand rammers or compactors to a possible maximum level of proctor density. Backfilling shall start only after ensuring the water tightness test of joints for the concerned sewer segments. However, partial filling may be done keeping the joints open. Precautions shall be taken against floatation as per the specified methodology and the minimum required cover.

6.13 List of approved makes

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering Pipe/equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

In order to achieve standardization for appearance, operation, maintenance and manufacturer's service, to the greatest extent possible, shall be the end products of one (1) manufacturer.

	Pipes	**Makes of Equipment**
	DWC Pipes	Prince Piping Systems, Mumbai.
		Gemini Pipes, Jaipur , Rajasthan, India
		Alom Poly Extrusions Ltd, Kolkata, West Bengal

Note-1: In the event that the contractor wishes to propose alternate vendor for the DWC pipes mentioned above, he shall submit the following during detailed engineering:

1) Demonstrate that the proposed makes are “Superior / Equivalent” to the approved makes.
2) Submit quality certificates that the Pipes/equipment adheres to.
3) Submit product brochures for the proposed equipment.
4) At least 10 successful individual installations/Sewer laying of similar size as per this contract.
5) Manufacturer to provide full contact information for each reference as part of technical bid.

SECTION-7

DUCTILE IRON PIPES (DI)

7.1 Manufacture of Pipe

DI pipes (Class K7 & K9) and fittings (Class K12) shall be in accordance with IS: 8329 and IS: 9523. Pipes and fittings shall be procured from reputed manufacturers with Engineer's approval. Engineer shall at all reasonable times have free access to the place where the pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and for witnessing the test and manufacturing. For pumping mains DI K-9 Class pipes shall be used.

All tests specified either in this specification or in the relevant Indian Standards specified above shall be performed by the supplier/Contractor at his own cost and in presence of Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to Engineer.

If the test is found unsatisfactory, Engineer may reject any or all pipes and fittings of that lot. The decision of Engineer in this matter shall be final and binding on the Contractor and not subject to any arbitration or appeal.

The pipes and fittings shall be stripped, with all precautions necessary to avoid warping or shrinking defects. The pipes and fittings shall be free from defects. Any defect in pipes and fittings in the opinion of Engineer shall be rejected and shall be replaced by new one.

In the case of spigot and socket pipes and fittings the socket shall be without the centre ring.

In the case of flanged pipes, the flanges shall be at the right angles to the axis of the pipe and machined on face. The bolt holes shall be drilled and located symmetrically off the centerline. The bolt hole shall be concentric with the bore and bolt holes equally spaced. The flanges shall be integrally cast with the pipes and fittings and the two flanges of the pipe shall be correctly aligned.

7.2 Materials

The materials used in the manufacture of pipes and fittings shall comply with requirements specified in IS: 8329 and IS: 9523.

7.3 Dimensions and tolerances

The internal diameter, thickness and length of barrel, dimensions of pipes and fittings shall be as per relevant tables of IS: 8329/IS: 9523 for different class of pipes and fittings. Each pipe shall be of uniform thickness throughout its length.

The tolerances for pipes and fittings regarding dimensions, mass, quality and deviations from straight line in case of pipes shall be as per IS: 8329/IS: 9523.

7.4 Testing of pipes during manufacture

(a) Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes and fittings as specified in IS: 8329 / IS: 9523. The frequency and sampling of tests for each batch of pipes shall be in accordance with IS: 8329. The test results so obtained for all the pipes and fittings of different sizes shall be submitted to Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS: 8329/IS: 9523.

(b) Brinell Hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS: 1500. The test shall comply with the requirements specified in IS: 1500/IS: 8329.

(c) Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

(d) Hydrostatic Test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in IS: 8329 / IS: 9523 for a period of minimum 15 seconds, during which the pipes shall be struck moderately with a 700 g hammer for conformation of satisfactory sound. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before surface coating and lining.

7.5 Laying of the pipe

Laying of DI pipes shall conform to the Code of practice of IS: 12288. Pipes shall be laid underground with a minimum earth cover of 1m. Pipes shall be generally laid in sections of 300 m each. Laying of pipes shall be as per Standard Specifications for Procurement of Project Works. All pipes, fittings and material shall be tested and approved by the Engineer before being laid. Any pipes, fittings or material placed before they are tested and approved shall be removed and replaced with tested and approved material. Before laying the pipe, necessary bedding shall be provided wherever required. Polyethylene sleeves wounded pipes shall be used for water logged areas as per specification and as directed by the Engineer.

7.6 Jointing of pipes

(a) General

Jointing of DI pipes and fittings shall be done as per IS: 12288 and manufacturer's recommendations. After jointing, extraneous material, if any, shall be removed from the inside of the pipe. Rubber sealing rings/gaskets used for jointing shall conform to IS: 638, IS: 12820 and IS: 5382.

(b) Spigot and Socket joints

These shall have sockets, which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS: 12820.

The gaskets/sealant used for joints shall be suitable for water conveyance. In jointing DI pipes and fittings, the Contractor shall take into account the manufacturer's recommendations as to the methods and equipment to be used in assembling the joints. In particular the Contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, so that the rubber ring as per IS: 12820 and IS: 5382 is correctly positioned in line, before the joint is made. The rubber rings and any recommended lubricant shall be obtained only through the pipe, supplier or as otherwise directed by the Engineer.

(c) Gaskets for Flanges

All gaskets used between flanges of pipes shall be of natural rubber conforming to IS: 638 of thickness 3 mm suitable for clear water conveyance and as specified by manufacturer.

(d) Flanged joints

These shall be of PN 1.0 rating and shall comply with dimensions and drilling details as specified in IS: 8329. These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts. All material shall be supplied by a reputed manufacturer and shall be approved by the Engineer.

Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The recommended bolting torque to be followed for assembling flanges shall be as specified in manufacturer's instructions. The practice of fully tightening the bolts one after another is highly undesirable. The bolts shall be of mild steel unless otherwise specified. They shall be coated with coal tar epoxy coating after tightening.

7.7 Coatings

(a) General

Unless otherwise specified, DI pipes and fittings shall be coated with Bitumen in accordance with relevant IS specifications. All buried DI pipes and fittings shall also have factory or site applied polythene sleeving. Coating shall not be applied to pipe and fittings unless its surface is clean, dry and free from rust. Pipe coatings shall be inspected at site and any damage or defective areas shall be made good to the satisfaction of the Engineer.

(b) Bitumen coating

Bitumen coating shall be of normal thickness of 75 microns unless otherwise specified. It shall be cold applied compound complying with the requirements of relevant Indian standards, suitable for tropical climates, factory applied in accordance with the manufacturer's instructions.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

(c) Cement mortar lining

All pipes and fittings shall be internally lined with cement mortar in accordance with IS: 11906. Cement mortar lining shall be applied at the factory in conformance with the above-mentioned standards. The cement used shall be High Alumina Cement. No admixtures in the mortar shall be used without the approval of the Engineer.

Pipe linings shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Engineer.

Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be as per IS: 11906.

(d) Marking

Marking shall be done as per IS: 8329 and IS: 9523 or any other relevant IS codes.

7.8 Carting & handling

Pipes and fittings/specials shall be transported from the factory to the work sites at places along the alignment of pipeline as approved by Engineer in lengths not more than the length of the transporting vehicle. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading. Every care shall be exercised in handling pipes and fittings/specials to avoid damage. While unloading, the pipes and fittings/specials shall not be thrown down from the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes and / or by any other approved means. Padding shall be provided between coated pipes, fittings/specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to the other. As far as possible, pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage (such as broken edges, cracking or spoiling of pipe) while unloading and shall be sorted out for replacement. Any pipe, which shows damage in the opinion of Engineer, shall be discarded and replaced by new one without extra cost. Dragging of pipes and fitting/specials along road or pipeline alignment shall be prohibited.

7.9 Methods of measurement for sewerage system

1. For manufacture, supply and delivery of pipes, measurement shall be taken for actual number of pipes multiplied by the standard length.
2. Laying and jointing of pipes and specials and valves will be measured in linear meters along the centre line of the pipes actually laid, jointed and tested and will be limited to the number of pipes x standard length + part length of pipe if any including specials and work is including the cost of rubber ring.

SECTION – 8

ACCEPTANCE TESTS

8.1 Check for Obstruction

a. As soon as a stretch of pipes whether of RCC Pipes or DWC or DI Pipes has been laid Complete from manhole to manhole, the Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of the pipes. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

b. If as a result of the removal of any obstruction the Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the length to be retested at the expense of the Contractor. Should such retest prove unsatisfactory the Contractor shall at his own expense amend the work and carry out such further tests as are required by the Engineer.

c. It shall also be ascertained by the Contractors that each stretch from manhole to manhole is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line.

8.2 Hydraulic Testing of Sewers

Immediately after the test with the double disc or cylinder as mentioned above has been completed and any defects thereby disclosed have been made good, the Contractor shall prove the joints of the stretch of under-ground pipes are water tight.

Each section of sewer shall be tested for water tightness preferably between manholes. To prevent change in alignment and disturbance after the pipes have been laid, it is desirable to backfill the pipes up to the top keeping at least 90 cm length of the pipe open at the joints. However, this may not be feasible in the case of pipes of shorter length, such as stoneware and RCC pipes. With concrete encasement or concrete cradle, partial covering of the pipe is not necessary.

If it is necessary that the pipelines are filled with water before commissioning the application of pressure to allow for the absorption by pipe wall as per relevant IS standards.

The Sewers are tested by plugging the upper end with a provision for an air outlet pipe with stop cock. The water is filled through a funnel connected at the lower end provided with a plug. After the air has been expelled through tile air outlet, the stop cock is closed and water level in the funnel is raised to 1.5 m above the invert at the upper end. Water level in the funnel is noted after 30 minutes and the quantity of water required is measured at an interval of 10 minutes to restore the original water level in the funnel. The pipe line under pressure is then inspected while tile funnel is still in position. There shall not be any leaks in the pipe or the joints (small sweating on tile pipe surface is permitted), any sewer or part there of that does not meet the test shall be emptied and repaired or re-laid as required and tested again. The leakage or quantity of water to be supplied to maintain the test pressure during the period of 10 minutes shall not exceed 0.2 litres/mm dia, of pipes per kilometre length per day. Water and other accessories required for testing shall be to the account of the contractor. In case of DI pumping/rising mains the hydro testing of the pipes shall be carried out as per IS 8329 provisions.

8.3 Testing of Manholes

The entire height of the manhole shall be tested for water tightness by closing both the incoming and outgoing ends of the sewer and filling the manhole with water. A drop in water level not more than 50 mm per 24 hours shall be permitted. In case of high sub-soil water, it should be ensured that there is no leakage of ground water into the manhole by observing the manhole for 24 hours after emptying it. Water and other accessories required for testing shall be arranged by the contractor at his own cost.

SECTION 9

TECHNICAL SPECIFICATIONS FORTRENCHLESS TECHNOLOGY

9.1 General Specification

These specifications are intended for general description of quality and workmanship of materials and finished work. They are not intended to cover minute details. The work shall be executed in accordance with best modern practices and using appropriate techniques of trenchless technology as necessary considering the physical and geotechnical site conditions subject to approval of the Engineer.

The quantities specified in the tender are only approximate and may change depending upon the actual site conditions and the work by trenchless technology shall have to be carried out at quoted rates only.

Contractor's obligations

The scope of this component of the contract is ***"design and build"*** pipelines laid by trenchless technology works like pipe jacking/ pushing, auger boring or micro tunneling and shall cover all equipment, designs, preparatory works, safety measures, testing and commissioning etc necessary for trenchless process. If the Contractor intends to use any other trenchless technique, it shall be with prior approval of the Engineer and at no extra cost of whatsoever nature to the Employer. The Contractor may request the Engineer for approval to a specific trenchless technique but Engineer's decision shall be final and binding. However, the Contractor shall be solely responsible for adequacy and safety of any of the techniques to be used. The Engineer reserves right to consider such alternative trenchless techniques.

The clauses in this section are meant to provide general guidelines and compliance requirements to the Contractor. It does not however relieve the Contractor from taking every other steps and precautions as deemed necessary to complete the installation of the pipelines successfully within the specified contract period and the amount.

The objective of the work is to provide and lay sewer lines meeting the hydraulic requirements for future and fulfilling the structural and serviceability requirements.

The Contractor's shall note that the alignment of the proposed works is in vicinity or affected by-

- Highways including existing CC road pavement and major junctions of roads
- Railroads including tracks on high embankments
- Crossing of major nalla/ drains/ water courses or in close vicinity of water bodies
- Laying of sewers in congested areas where traffic diversion is not permitted

Furthermore, the consideration that a method permitted as a suitable method of installing the sewers by trenchless technology shall not relieve the Contractor in any way from his prima facie obligation and responsibility under the contract to successfully install the pipelines without causing interruptions to traffic or inconveniencing citizens or road users and within the specified contract period and contract amount.

The Contractor's rates in the Bill of Quantities shall be deemed to be for installing the pipelines successfully including all appurtenant and/or ancillary works within the specified contract period regardless of the method.

It shall be obligatory for the Contractors to carry out geotechnical and other investigations including buried services detection by appropriate equipment and satisfy themselves and the Engineer of the adequacy of their testing.

The Employer / Engineer shall not be responsible for any changes in method or equipment necessitated during execution of the work and it shall be contractor's sole responsibility to ensure deployment of proper method and equipment for the work.

The Contractor shall, on his own accord collect information or conduct investigations about likely geotechnical conditions at the site. Any risks assumed by the applicant by solely depending on his current knowledge of the site of the information currently available on the geotechnical conditions, buried services, any physical obstructions shall be entirely his own and he shall be solely and fully responsible for any consequential expenses arising as a result of the risk he assumed. He shall not resort to any compensation claim under the contract for differing ground condition that he may encounter as a result of assuming the risk.

The extent and scope of the geotechnical and other investigations along the pipeline route would depend on the type of the equipment and systems that he proposes to use in the project.

The applicant shall ensure that the Trenchless Technology system shall successfully excavate in wide ranging ground conditions, from soft ground, sandy/ silty strata to hard rock strata or strata with boulder or high water table etc. likely to be encountered at the sites. For soft and slushy grounds the contractor shall adopt appropriate ground improvement method to suit the construction method as well as to ensure long term stability of pipeline laid during its lifespan.

Scope of Work

The scope of work under this component shall include but not be limited to the following :

a. Thorough geotechnical investigations needed for ground assessment and sewer laying using trenchless work.
b. Detection and mapping of buried services in vicinity of the proposed alignment and providing a diversion or relocation plan. Temporary diversion of such utilities in consultation with the concerned owners and the Engineer of the Contract shall be at risk and cost of the Contractor.
c. Arrange for permissions from various authorities including railways and pay necessary charges which shall be reimbursed by the Employer at actuals.
d. Construction of shafts/ insertion or access pits for the proposed method using appropriate excavation technology such as well sinking or sheet piling or trench box shoring or any other type of shoring system with detailed design including leaving any type of shoring system in trenches as necessary.
e. Design, manufacture and supply of appropriate type of pipes suitable for the technique to be adopted including RCC Jacking pipes conforming to JSWAS A-2/ A-6, HDPE pipes conforming to IS 14333, DWC pipes conforming to IS 16098 Part 1 and 2, MS pipes for manual pipe pushing/ jacking conforming to IS 3589as acceptable to the Engineer. The scope shall also include all types of carrier pipes besides the sleeve pipes.
f. Construction of manholes and appurtenances as per the specification requirements or as directed by the Engineer.
g. Planning, Detailed Design and construction of interconnection with existing system for connection of flows to the newly laid lines.
h. Excavation as necessary apart from construction of shafts
i. Backfilling of excavated trenches and reinstatement of surfaces

j. Rectification of any damage caused to adjoining structures
k. Management of excavated material including disposal of surplus material in environment friendly manner as directed
l. All ancillary and enabling works needed for the main works as mentioned above
m. Submission of as-built drawings (Soft copy and hard copies as required by the Engineer)

9.2 Selection of trenchless technique

The technique of trenchless technology to be adopted shall take in to account the physical site conditions, geotechnical conditions, arrangement of pipes, obligatory requirement of various authorities etc as mentioned below.

General approach for selection of trenchless technique shall be as under-

A. Application-
    a. Sewer line carrying domestic sewage
B. Function
    a. Gravity
C. Arrangement of pipes
    a. In casing- Casing + Carrier
    b. Direct carrier
D. Dimensional details
    a. Diameter (Jacking and Carrier)
    b. Depth of installation
    c. Obligatory length of single drive
    d. Limiting length of drive
E. Geotechnical aspects
    a. Soft ground (Clayey)
    b. Sandy/ silty
    c. Murum
    d. Soft/ Weathered rock
    e. Hard rock
F. Physical conditions
    a. Along a narrow road
    b. Along a wider road with heavy traffic
    c. Railway crossing
    d. Highway crossing/ Major Access Controlled Roads
    e. River/ Nalla/ Drains/ Water course crossing

G. Material of casing and carrier pipe
    a. RCC/DI

b. HDPE/DWS

i. Solid Wall

ii. Double Wall

c. MS

H. Arrangement desired

a. Carrier and Sleeve

b. Direct installation

The Engineer shall in general consider the above aspects for considering appropriate trenchless at a particular stretch of the work.

Trenchless techniques considered suitable are -

A. Pipe pushing/ Jacking

B. Auger boring

C. Micro tunneling

D. Any other method such as HDD

The Contractor may request for approval of the Engineer to any other technique but the Engineer's decision shall be final and binding on the Contractor.

9.3 Terminology and general description

Definitions

For the purpose of this contract document, the technical terms pertaining to micro tunneling works and their functional details are defined below. The definitions herein are meant only as guidelines. If other (or new) definitions or technical terms are used by the Contractor in his submittals, they shall be clearly defined by him.

Micro tunnelling

Micro tunneling is a process of accurately excavating, tunnels for installing underground pipelines, using steerable laser guided remote controlled shields of required diameters .Micro tunneling permits accurate monitoring and adjusting of the alignment and level (either manually or automatically) as the excavation proceeds.
It is an art of accurately installing pipelines (usually 450mm diameter and above which may be up to 2400mm or even beyond), without digging up of ground surface, using a laser guided remote controlled shields for tunnel boring using slurry or EPB shields and pipe jacking technique for lining the bore with the product pipe.

The process of installing a pipeline by micro tunneling and pipe jacking system comprises five parts:-
(a) Micro tunnel boring machine (Shields)

(b) Automated spoil removal system
(c) Jacking system for pushing the jacking pipe and later on carrier pipe as needed
(d) Guidance system to guide the tunnel excavation
(e) Remote control system to operate the shield and other paraphernalia equipment.

Manual Pipe jacking

It is a process of lining a underground bore formed by manual excavation under a shield or other means and pushing specially designed jacking pipes (reinforced concrete or other pipes) simultaneously into the excavated tunnel bore, from a shaft (known as jacking shaft) to another shaft (known as receiving shaft).

Auger boring

Auger boring is a process of accurately excavating through ground using flights of augers for spoil removal and drill heads catering to various types of soils ranging from soft ground to rock for installing underground pipelines, using steerable guided remote controlled shields of required diameters generally 450mm to 1000mm. The method may involve pipe installation using single stage or multi stage operation using flight of augers and sections of the pipe to be installed.
A type of directional and guided boring machine, which uses auger flights to remove the spoil through separate casing placed through the product pipeline.
In this system, the excavated materials are continuously removed by an encased screw conveyor attachment connected to the rear of the tunnel cutter face. By controlling the speed of the screw augur and the outlet of the conveyor at the spoil discharge point, the excavated soil at the tunnel face can be kept under a desired balancing pressure to support the tunnel face.

Micro Tunnel Boring Machine (shield)

It is mechanized, steerable mini boring machine (or shield) equipped with suitable cutter head in front to excavate smaller diameter tunnels under controlled conditions in which the tunnel face and ground water pressure are continuously balanced as the shield excavates and moves forward. The operation and steering of the shield are remotely controlled with the aid of laser and/or CCTV system.
There are three systems available for the balancing the face pressure below:

Earth Pressure Balance (EPB) system

Earth Pressure Balance (EPB) is a system in which mechanical pressure is applied to the material at the face and controlled to provide the correct counterbalance to earth pressures in order to prevent heave or subsidence. The system allows excavation of the materials under controlled conditions so that no free flow of soil or ground water is permitted at the tunnel face. The spoil removal rate and the speed of the shield advancement are thus controlled either fully or semi-automatically.

Slurry Pressure Balance (SPB) system

It involves balancing the face pressure using a mechanical tunneling shield with closed face, which employs hydraulic means for removing the excavated material, and balances the ground water pressure by mixing the excavated stuff with water to form slurry. In this system, the excavated materials is continuously mixed with water and or bentonite to convert into slurry and kept under a desired balancing pressure to support the tunnel face. The slurry is pumped to the ground surface where the solids are separated for disposal and the water is pumped back to the tunnel face for further utilization.

Automated spoil removal system

This system conveys the excavated spoil from the tunnel face to the ground surface for disposal. The spoil removal rate and the speed of the shield are fully or semi-automatically controlled in such a way to achieve minimal heave or settlement. The common systems available for the conveyance of the spoil and they are slurry system and augur system.

Slurry system employs hydraulic means for removing the excavated material by mixing the excavated stuff with water to form slurry. In this system, the excavated materials is continuously mixed with water and or bentonite to convert into slurry which is pumped to the slurry separation tank at ground level where solids can be separated from slurry and water reused.

In case of EPB shields, the removal of spoil is through a method which used balancing force of the excavated soil and the soil is generally removed using augers or belt conveyors.

Jacking System

The jacking system comprise high thrust hydraulic jacks mounted in a jacking frame capable of exerting the required jacking force against a purpose built thrust wall to push the pipes and the shield forward through the ground. The jacking force is transferred evenly to the jacking pipe through a push ring connected to the pipe.

Guidance System

The guidance system comprises a laser beam device or a theodolite with laser beam attachment or visual guidance system such as CCTV. The device is installed in the jacking shaft and the beam is set to the desired level, gradient and alignment.

Some machines have photo sensitive cells on the target panel located at the rear of the shield which converts the laser position into digital data. The data are then electronically transmitted to the operator's control panel where digital readout of the location can be made. Some modern shields have built-in capabilities to use the digital data and automatically make necessary steering adjustments to guide the machine to the true alignment and level.

The contractor shall submit complete details of the guidance system he proposes to use and shall incorporate appropriate check points and hold points in the Quality Assurance Manual that he shall implement in the contract. The system shall provide continuous recording of the details of drive capturing various parameters not limited to the horizontal alignment or x & y coordinates, vertical alignment, roll, pitch, torque, jacking force, laser positions, jack positions, temperature of hydraulic system, slurry/ muck flow rates, etc. and a detailed printout of such parameters shall be submitted to the Engineer at the end of every day.
The laser source or theodolite shall be firmly supported in the jacking pit so that it is independent of any movement that may take place during the micro tunneling and jacking operation.

Remote Control System

All micro tunneling systems rely on remote-control capability. The control system monitors and controls the steering of the shield, spoil removal system (slurry or augur or vacuum), jacking system and guidance system. The system operation varies from totally manual to fully automate. The remote control system is usually housed in portable control cabin.

The control cabin shall be located near to the jacking pit so that the operator can visually monitor the activities in the pit. Where it is not possible to locate the control cabin near to the pit due to space limitations, a CCTV camera system shall be set up in the pit to allow the operator to monitor the activities in the pit.

For the manual operating system, the operator's skill is very crucial for a successful completion of the project. The operator shall have experience of at least 10 years of piloting micro tunneling equipment of which in driving.

The operator shall monitor all the information and continuously feed into the control panel as necessary. He shall be alert at all time and shall observe the crew's activities and other site activities, evaluate the information and make appropriate operational decisions. The information relayed back to the operator shall be audible, tactile and visual as The MTBM shall have facility to transmit sounds and vibrations from the excavation face to the operators to enable him to make appropriate operational decisions. Notwithstanding the ability of the equipment to keep automatic drive records, the operator shall monitor and keep record of line and grade of the machine, cutter head torque, thrust, RPM, steering pressures, slurry flow rate, pressures of slurry systems and rate of advancement.

In fully automated system, the machine acquires and evaluates the information and select the operational steps for automatic steering of MTBM. The information collected shall be logged in a microprocessor to obtain a printout as necessary.

The contractor shall incorporate check points and hold points for the guidance control system in the Quality Assurance System that he shall implement in the contract.

Supplementary systems

The supplementary system required for micro tunnelling and pipe jacking operation shall include Muck disposal system, pipe handling systems, pipe lubrication system, Grouting system, Guide rails, and Entrance and Exit rings and power supply systems.

Jacking shaft (or Jacking Pit)

Jacking Shaft is an important temporary structure from where jacking operation is performed. The shaft is usually rectangular or circular in shape and built using liner plates, sheet piles or timber shoring. The size of the shaft shall be such that it is capable of accommodating the jacking equipment (and also the shield), jacking pipe, thrust and entrance wall, Laser source and other paraphernalia or enable construction of manhole or chamber as needed. This may correspond to the position of the manholes and the size and shape shall take cognizance of the same. The requirement for jacking shaft shall take full cognizance of the available working space and intended equipment. If it is intended to have a common shaft for both the drives, the size of shaft shall be selected accordingly.

Receiving shaft (Receiving pit)

A purpose built temporary structure to receive and remove the tunneling shield after its completion of a tunnel drive. The shaft is also rectangular or circular in shape and smaller than the jacking shaft. The size shall be sufficient enough to accommodate the tunneling shield when it emerges into shaft after completion of a tunnel drive or construction of manhole or chamber as needed.

Footprint

The footprint of a micro tunnel drive shall be taken as the net area occupied by the jacking or receiving shafts. The size of the footprint depends on many factors including the microtunnelling system and the length of jacking pipe used. The footprint requirement shall be an important factor, especially in congested and narrow roads when selecting the microtunnelling system for a project.

Thrust wall

Thrust wall is a temporary concrete or steel structure built within the jacking shaft to transfer the jacking force to the ground during jacking operation. The jacking shafts may often have more than a single thrust wall and each thrust wall shall be perpendicular and square to the pipeline to be jacked. The thrust walls shall be in good contact with the soils behind so that wall can transmit the jacking force effectively to the ground without affecting the shoring system.
All the affected thrust wall shall be demolished fully or partly after completion of jacking operation involving in that wall.

Entrance Ring

A steel flange fitted with a rubber seal (a 10mm to 20mm thick circular rubber gasket whose outside diameter is same as that of the steel flange and the inside diameter is smaller than that of the jacking pipe) installed perpendicular to the pipeline at the entrance. The purpose of the rubber seal is to prevent the slurry or ground water from entering into the shaft through the pipe entrance. The entrance seal shall be capable of withstanding anticipated pressure of the pressurized slurry with bentonite and/or the hydrostatic pressure

Exit Ring

This is similar to the entrance ring except that the internal diameter of the rubber seal is much smaller than that of the jacking pipe and is installed to prevent the slurry or ground water from escaping the tunneling machine when it emerges at the receiving shaft. The exit seal shall be capable of withstanding anticipated pressure of the pressurized slurry with bentonite and/or the hydrostatic pressure.

Guide Rails (or Jacking Table or Frame)

To facilitate placing of the micro tunnelling machine and pipes in the jacking shaft, a set of guide rails are installed in position on the base of the shaft. The guide rail assembly (also known as jacking table/ frame) shall be carefully set up in the shaft to correct alignment and gradient so that the pipe when placed on it stays in line with and square to the pipeline alignment. The guide rail assembly shall be independent of the thrust wall so that it is not disturbed due to jacking force exerted onto the thrust wall.

Thrust Pressure Plate

The thrust pressure plate is usually a 50mm or 100mm thick steel plate installed between the jacks assembly and the thrust wall. The pressure plate enables the concentrated jacking load from the jacks to be transmitted evenly to the thrust wall,

Intermediate Jacking Station

For longer distance jacking, intermediate jacking stations, comprising a telescopic type jacking pipe assembly (usually made of steel), are used. A set of inter jacks and push ring are installed around the inner side of the female pipe of the telescopic pipe assembly. The intermediate jacking pipe assembly shall be installed at appropriate point and jacked-in along with the other jacking pipes. The contractor must plan for number of intermediate jacks as necessary for successful completion of the drive without overstressing the jacking pipes.

Cutter head (Micro tunneling)

It is usually a disc shaped wheel mounted on the face of the micro tunneling machine (shield) and is driven by hydraulic or electrical motor, located within the machine. The excavation capabilities of a micro tunneling machine depends very much on the type of cutter head used, its speed of rotation and average and peak torque etc.

Different types of cutter head configuration are used in micro tunneling machines to suit the type and nature of the ground through which tunneling is to be carried out. For example in soft ground tunneling the cutter head shall have bits arranged in such a way to cleave and guide the soil into a chamber behind the cutter head through the openings provided in the cutter wheel.
In the case of rock or hard ground tunneling the cutter head shall be equipped with suitable bits, roller bits or disc cutters for effective transfer of cutting energy to rock. In case of clay/ sand or mixed ground conditions, the cutter head shall be designed to suit the geotechnical conditions involving the site.

Cutter head (Auger boring)

In case of auger boring in rocky strata, the equipment shall be fitted with appropriate tools like “Front Steer” or “Pilot Tube System- RVS” or active and passive hole openers as necessary for successfully drilling in the anticipated ground.

Jacking Ring

Jacking ring or thrust plate is a purpose made structural fitting which shall be installed between the jacking assembly and the jacking pipe to transfer the point loads from the individual jacks into evenly distributed jacking force to the pipes being jacked. The ring shall be fabricated and machined, if necessary, so that it fits exactly onto end of the jacking pipe.

9.4 Performance Requirements

9.4.1 Design Life

For the purpose of designing the pipelines and the associated structures, the design life shall not be less than 60 years. The materials incorporated in the works and the workmanship shall be of required quality to sustain the specified life span.

9.4.2 Level and Alignment Accuracy

The pipes shall be installed into place, true to line and level. The maximum tolerance allowable in the displacement of the center line of the laid pipe from the design center line is 50 mm in the horizontal plane and 25mm in the vertical plane but there shall be no back-fall at any point.

There shall be provision to prevent the relative movement between pipes at the joints by the use of steel gaiters or other approved methods during jacking operation. A packing piece of compressible material shall be provided at each joint and shall be securely held before the pipes are lowered into the thrust pit. Details of proposals shall be submitted to the Engineer for approval.

The Contractor shall be responsible for ensuring accuracy of pipe laying by micro tunnelling and shall take due cognizance of the ground conditions.

9.4.3 Limits on ground settlement and upheaval

The trenchless technology method adopted by the Contractor shall be such that the initial surface settlement measured directly above the front face of the shield or boring equipment during the tunneling/ boring/ pipe jacking operations does not exceed 15mm and the maximum surface settlement after the tail voids are grouted shall not exceed 25mm. The affected ground and the structures shall be subsequently reinstated to their original condition at Contractor's risk and cost.

For the sections of pipeline crossing under nallas, roads and railways the Contractor shall be required to incorporate in his tunneling method measures to arrest the expected settlements so as to safeguard the integrity of the road surfaces and collapse of nalla bed. The Contractor shall ensure that the traffic flow along the roads is not affected in any way as a consequence of his work.

In case of the works of laying sewers across any nallas or water courses, it may be necessary to provide kentledge to prevent upheaval or escape of slurry or to ensure proper overburden above the crown of the pipe being laid by microtunnelling. The contractor shall ensure that proper arrangements for non disruption of the flow through such nalla or water course are made by adopting appropriate measures approved by the Engineer. Such kentledge in drains shall be removed and waterway cleared after completion of the work. No extra payment shall be admissible for provision and removal of such kentledge.

9.4.4 Providing temporary access to the jacking or receiving shafts

The alignment/ placement of manholes and shafts might have to be taken outside the carriageway in to kutcha portion.

Where it is seen that the locations of jacking and reception shafts do not have direct access from roads for taking construction plant equipment, the Contractor may have to provide temporary access including access over barges/ boats and also to erect marooned barges at the site of the reception shafts. Any temporary arrangement shall be subsequently removed, and the site conditions restored to their original state upon completion of the work.

9.4.5 Limitation on Footprint and weight of machine

The Contractor shall be deemed to have visited the sites and carefully planned and located the shafts at convenient points so as to minimize the working area to be occupied by the footprint. The contractor shall be deemed to have allowed for such site constraints and measures required, including working in the night and construction of decking over the shafts, provision of access roads for construction plant and machinery, to allow the traffic to flow, in his rates. He shall take the site constraints and restrictions into consideration when selecting the trenchless technology system. It is necessary to pay close attention to the ground conditions, bearing capacity of the ground at appropriate level and select the head and equipment accordingly. The weight of the equipment selected should be such as to eliminate equipment settlement during driving the tunnel and installation the pipes.

9.5 Contractor's submittals

9.5.1 General information on submittals

To ensure compliance with the requirements specified in the Contract, the contractor shall make a number of submittals as described in the following clauses to the Engineer for approval by the specified time. The contractor shall ensure that the submittals prepared are of good professional standard, comply with all the requirements specified in the contract and complete with all details and information to enable the Engineer to evaluate and approve the submission. It shall be clearly understood by the contractor that he shall not commence any work without the approval of the submittals by the Engineer.

Submittals by the contractor shall, include:

- Contractor's method of construction
- Microtunnelling equipment description and literature
- Jacking system and maximum jacking loads
- Pipe designs and shop drawings and calculation demonstrating the ability to sustain maximum jacking loads
- Intermediate jacking stations details
- Lubrication system
- Bentonite injection system details
- Ground water control details
- Entry and exit details
- Jacking and receiving shaft design details
- Thrust block details
- Muck removal and disposal
- Buried services details
- Detection equipment or any other trenchless technology system equipment etc.

All submittals shall be submitted by the Contractor in accordance with schedule mentioned.

9.5.2 Submittal on Contractor's method of construction- Microtunnelling including construction of shafts

The submittal shall contain a detailed explanation of various steps involved in the construction process. They shall include details of the equipment, specific manufacturer's instructions and guidelines pertaining to the project, a methodology statement outlining the operation of the equipment and, details of materials including pipe materials, rubber ring, and compressible packers and jointing of pipes.

The submittal shall also include construction details of other permanent and temporary structures such as jacking and receiving shafts, cast in-situ and precast manholes, or brick masonry manholes, thrust walls, and entry and exit of the shaft. The details of other equipment such as intermediate jacking stations, spoil removal system including slurry and feed pumps, control systems, slurry tanks and associated machinery, jacking frames, spacers, thrust ring etc., shall also be included in the submittal.

9.5.3 Submittal on geotechnical profile and geotechnical reports along the pipeline route

The Contractor shall establish the subsurface ground conditions and their range of variability along the pipeline before embarking on the works. He shall clearly identify the types of soil or rock that is likely to be encountered during boring or tunneling along the entire pipeline alignment. If found necessary, he shall carryout simple probing techniques. (Geophysical soundings or Seismic refraction method and soil resistivity tests)

He shall prepare a comprehensive geotechnical profile along the pipeline route with detailed descriptions of the types of soil or rock to be expected during boring/ tunneling.
The Contractor shall endeavor to carry out essential geotechnical investigations and tests (Field as well as laboratory) immediately after award of the work for enabling him to select appropriate equipment/ methods. The Contractor shall be solely responsible for geotechnical investigations and the inference drawn from such investigations as well as the adequacy of the equipment and method adopted by him. However, other progress of works like construction of shafts etc. may be continued simultaneously.

9.5.4 Submittal on jacking pipe design and carrier pipes

The contractor's attention is drawn to the requirement pertaining to the design, manufacture and handling of the jacking pipes. The jacking pipes shall be manufactured in accordance with JSWAS A2 or BS 5911 Part 120 or equivalent standard approved by the Engineer. At the same time the pipes shall meet the test requirements for NP4 pipes under IS 458.

The Contractor shall with the approval of the Engineer, engage a reputable pipe manufacturer to design and manufacture the jacking pipes. The submittal shall include the manufacturer's name, address, contact telephone and facsimile numbers and the manufacturer's quality assurance /control and testing plan for the jacking pipe.

The manufacturer's representative's name shall be also included in the submittal. A dimensioned drawing of the jacking pipe with design calculations from the manufacturer shall be also submitted to the Engineer for approval.

The submittal for jacking pipes shall include particulars of the pipe moulds, casting facility, QA/ QC for pipes, anti-corrosive protection to the pipe. The submittal shall be accompanied with a letter from the plant owner giving guarantee for delivery of the pipes in accordance with the schedule of work as planned by the contractors and as directed by the Engineer / Employer.

The Contractor shall furnish a Memorandum of Understanding between the RCC pipe manufacturer and the Contractor for supply of Jacking Pipes and also an undertaking from the pipe manufacturer that they possess a valid BIS license and have supplied at least 500m of jacking pipes of 1000mm and above which have been successfully installed by micro tunnelling anywhere in India.

In case MS jacking pipes are considered necessary as sleeve pipes as a requirement of contractor's methodology for micro tunneling and pipe jacking, the same shall be at no extra cost to the Employer.

The MS sleeve pipes in such case shall be of appropriate size to accommodate carrier pipe of required ID and shall conform to IS 3589 and shall be coated with anticorrosive coating as per the IS code requirements. In such cases RCC carrier pipes conforming to IS 458 or HDPE pipes conforming to IS 14333 or IS 16098 Part 1 or 2 shall be installed inside the sleeve pipes.

9.5.5 Submittal on microtunnelling/ pipe jacking/ auger boring system

The bidder / Contractor shall furnish name of the micro tunneling/ auger boring system, model, manufacturer's technical literature for the equipment and all other data along with their bid. Any

amendments deemed necessary by the Contractors shall be submitted along with the geotechnical profile within 21 days of submission of geotechnical profile to the Engineer. The submittal shall include information to ensure that the micro tunneling/ auger boring equipment proposed for the project meet with the general requirements specified in these specifications and also the anticipated geological conditions. The submittal shall also include a certification from the manufacturer of the equipment about adequacy in the anticipated geotechnical conditions as also design calculations showing maximum anticipated jacking or pullback force and torque needed for tunneling/ boring. The details shall also provide information of rock cutting tools or heads, spoil removal methods, guidance systems, jacking system and capacities, interjack systems, hole lubrication systems etc.

9.5.6 Submittal on site layout

Contractor's attention is drawn to various clauses in the document about the site constraints and space availability in all the sites. The contractor shall carefully examine the site and prepare site layout plans showing extent of work site, the arrangement of various ancillary equipment required for works, such as approaches for equipment, spoil removal equipment and slurry tanks, bentonite systems/ mud recycling system, generators, control cabin, tracking facilities, crane, storage of pipes etc for each drive and submit them progressively to Engineer for approval.

9.5.7 Submittal on existing pipe network details, ground and invert levels, location of shafts and new pipeline alignment

The contractor shall survey and verify the as-built invert levels of the upstream and downstream pipelines and manholes shown on the contract drawings for all the sites. The contractor shall confirm or insert the correct as-built levels in the contract drawings and submit them to the Engineer for necessary amendments and re issue of the contract drawings for construction. Under no circumstances the contractor shall commence works without verifying the as-built levels and obtaining the approval of the Engineer.

The Contractor will be required to set out and plan the actual placement of the alignment for the pipe laying well in advance of actual excavations. Trial holes/ probing and other preliminary surveys must be carried out and the resulting information carefully plotted.

For convenience of construction, if the Contractor prefers changes to the pipeline alignment or the location of manholes, he shall submit such changes to the Engineer for prior approval. The Engineer would evaluate and approve if the proposed changes are found to be economically and technically, and functionally acceptable. It shall be clearly understood by the Contractor that any construction risks and additional costs arising as a result of Contractor's changes made to the original pipeline design shall be entirely borne by the Contractor.

9.5.8 Submittal on jacking and receiving shaft design

The Contractor shall submit the design and construction details of the jacking and receiving shaft and their proposed locations along the pipeline route to the Engineer for approval. The Contractor's design shall ensure that the shaft dimensions are absolute minimum required and method of construction shall be such that the shafts are constructed without causing unacceptable obstruction to the existing traffic flow in the vicinity of the construction. The minimum size of the shaft shall, however, permit construction of appropriate manhole / valve chambers as per the requirements. The Contractors shall

also submit design and construction details of decking, if required, for the shaft. The Contractor shall be deemed to have allowed for in his Bid for such decking work necessary to maintain the traffic flow. The submittal shall also include details on shoring system, entry and exit arrangement, thrust wall layout and design details, general layout of guide rail and jacking table arrangement etc.

In case the shafts are to be constructed by method of well sinking, the contractor shall provide complete design details along with method of sinking, soil removal, dewatering, concrete steining, kentledge arrangement etc. for approval of the engineer.

In case of shafts in the form of RCC wells, branch connections to the manholes constructed inside the well shall be provided at no extra cost to the Employer.

9.5.9 Submittals for obtaining approval from authorities

The Contractor shall submit separate schedule for obtaining approval of various authorities and obtain specific permission or approval through the engineer.

9.5.10 Submittal on buried services and obstructions

The Contractors shall investigate and determine the actual location of the buried or over the ground services (Metallic and non metallic) and physical obstructions, if any, along the pipeline route and at his chosen locations of the jacking and receiving shafts, and submit service location drawings to the authorities responsible for electricity, telecom, water, pipeline, gas etc and obtain their approval or permission to excavate in their vicinity. The contractor shall use a good quality Ground Penetration Radar (GPR) for this purpose and shall submit complete details of the equipment and procedures for field investigations and laboratory/ desk analysis of the data captured in field.

The Contractor shall not interfere with the operation of any existing or proposed service. He shall carefully plan the pipeline route and the locations of the shafts and manholes and shall identify the services that require diversion well ahead so as to give ample time to the authorities to divert the services or give approval to carry out the diversion by others. Where applicable, the Engineer would assist the contractors in getting the approval as expeditiously as possible from authorities.

If in the opinion of the Engineer any services that are within the manhole proper or affecting the alignment and require permanent diversion, they shall be diverted at the expenses of the Corporation. Expenses for all other diversions and temporary protection of services shall be borne by the Contractor.

Any consequential delays or expenditure arising from Contractors' carelessness or lack of foresight on this matter shall be entirely borne by the Contractor.
The Contractor shall fully co-operate with the Engineer and the authorities and shall have no claim for delay due to such relocation of services.

The Contractor shall allow for sufficient time for getting the permissions from the authorities.

9.5.11 Submittal on monitoring of ground settlement and upheaval

The Contractor shall monitor ground movement daily at the start of jacking operation and end of the jacking operation on that day and submit in an approved format the settlement or upheaval caused by the micro tunneling and pipe jacking works to the Engineer.

It shall be incumbent upon the contractor to measure ground movements along the route of pipeline laid for a width of at least 5m or 2 times the depth of the pipe being laid on either side of the center line using appropriate equipment such as seismographs, accelerometers during construction and measure them at least once in six months during the defect liability period and in case any settlement of ground or pipeline is observed, the contractor shall take remedial measures at his risk and cost.

The contractor shall also conduct a joint survey of structures in vicinity to monitor any cracks or signs of distress and take timely remedial measures at his risk and cost.

9.5.12 Submittal on Safety

The Contractor shall be solely responsible for safety of the workmen, Engineer's staff and third party. The contractor shall implement a comprehensive safety plan for his work people and Engineer's/ Employer's staff or Third party. He shall comply with all relevant acts governing safety on construction site. He shall submit to the Engineer the details of the arrangements he made with the fire brigade, local health authorities and the availability of medical staff, first aid equipment ambulance, sick bay etc. He shall give the names and contact telephone numbers (24 hours) of the occupational health and safety personnel. Beside he shall submit a list of safety equipment that he would provide to all the workers on site. The Contractor shall appoint a Safety Officer or Safety Engineer at all times who shall be the responsible person for all safety related matters pertaining to the contract. Name of such person shall be communicated along with the submittals on safety. The contractor shall comply with the guidelines issued by any competent authority regarding safety at work site especially safety of persons working inside any pipeline- new or functioning. This shall be consistent with the contractor's obligations under the GCC/ SCC.

9.5.13 Submittal on quality assurance/control plan

The Contractor shall implement a Quality Assurance Program approved by the Engineer for the manufacture of jacking pipe and for actual installation of the pipes trenchless method on site. The Quality Assurance Programme shall be maintained in accordance with the provision of the manual. No works shall commence until the Quality Assurance Manual has been approved by the Engineer.

The Contractor's Quality Assurance System shall incorporate but not be limited to the following:
(i) The Quality Assurance and Quality Control procedures covering all materials, design, manufacture, supply and installation carried out by the Contractor and any of his sub-contractors and pipe manufacturers.
(ii) Such tests necessary to demonstrate that materials comply with the requirements of this specification and the requirements of the relevant Standards and Codes.
(iii) Contemporary records to be maintained pertaining to progress of the work.
The QAP shall mention check points and hold points and must be scrupulously followed.
The Contractor must be ISO 9001-2015 certified organization and must submit the Quality Manual for implementation during execution of the works.

9.5.14 Submittal on Contractor's personnel

The Contractor shall appoint a dedicated Project Manager along with at least two dedicated site engineers experienced in micro tunneling work for this contract.

The Contractor shall note that the skill of MTBM operator and their assistants is crucial for successful execution of work. The contractor shall submit complete information for the operators proposed to be employed for the work. At least one MTBM operator must have an experience in operating MTBM in India.

The Contractor shall be required to deploy the key staff as committed during the bidding process. No change in the personnel shall be permitted subsequently without written approval of the Engineer. He shall submit the diagram showing the communication link within the site to Contractor's Head Quarters along with designation and telephone numbers of key staff for the Engineer's record. The Engineer reserves his right to reject any person who he thinks not suitable for the contract and the Contractor shall be obliged to replace such person immediately.

9.5.15 Submittal on remedial measures to be adopted by the Contractor

The Contractor shall take each and every precaution to ensure that the tunneling or drilling equipment will successfully excavate along the chosen pipeline alignment before he commences the operation. Once the tunneling/ drilling is commenced in a drive, the Contractor will be held fully and wholly responsible for the successful completion of the tunnel excavation and retrieval of the shield from the receiving shaft or for completion of pilot bore and hole enlargement upon back-reaming. In the event of inability to complete the drive, due to break down or any other reasons, the Contractor shall be fully responsible to recover the equipment safely from the ground and restore the incomplete work to the original condition at his risk and cost by a method approved by the Engineer and the concerned authorities within time stipulated by the Engineer or the concerned authority.

It shall be clearly understood by the Contractor that the occurrence of such an event is preventable as such an occurrence is generally due to Contractor’s negligence in the “preventive maintenance” of the equipment or driving of it to true level and gradient or his failure to determine accurately the expected ground conditions before commencement of the excavation.

The Contractor shall in his submittal clearly state the measures that he would implement to retrieve the shield without causing interruptions to railway, highway or road traffic etc., and without causing any damage to the property. The cost for such retrieval measures or any consequential expenditure or delays arising from thereof shall be entirely borne by the Contractor. Any failure to remedial measures shall be entirely at the risk and cost of the Contractor.

Any abandoned hole or tunnel must be grouted completely at the Contractor’s cost so as to prevent subsequent settlement.

9.5.16 Submission on work schedule

Notwithstanding the obligations of the contractor under the GCC, the contractor shall submit a detailed work schedule with suitable milestone events. The work schedule shall also take cognizance of the monsoon season, water levels and their fluctuations in the reservoir and their impact on ability to carry out the work etc.
A baseline schedule shall be submitted along with the bid which shall be frozen within 15 days of award of the work to successful bidder.

9.5.17 Effect of Approval and Acceptance of Proposals

Approval or acceptance by the Engineer of any proposal for executing the Works, including drawings, specifications or resources employed under the Contract shall not relieve the Contractor of his responsibility for any errors thereon and shall not be regarded as an assumption of risk or liability by the Corporation. The Contractor shall have no claim under the Contract on account of the failure or partial failure or inefficiency of any plan, method of work or equipment approved or accepted by the Engineer. Such approval or acceptance shall be considered to mean only that the Engineer had no objection to these proposals.

Notwithstanding any approval or acceptance by the Engineer, the Contractor shall remain fully responsible for completing the Works correct in every detail.

9.5.18 Schedule of submittals

Below is a general schedule of submittals pertaining to trenchless works by the contractors

Sr. No	Description	Schedule of submission
1	Contractor's method of construction.	Along with the bid.
2.	Geotechnical profile along pipeline route.	Within 30 days of date of commencement letter.
3.	Jacking pipe design	Along with the bid.
4.	Micro tunneling system.	Original submission along with the bid and any changes necessitated by the geotech investigation shall be submitted within 15 days of submission of geotech profile.
5.	Site layout	Within 45 days of commencement dates.
6.	Proposed Intaek Location and shafts and new pipeline alignment.	Within 45 days of commencement dates.
7.	Jacking & Receiving shaft design.	Along with the bid. Any changes necessitated by the geotech investigation shall be submitted within 15 days of submission of geotech profile.
8.	Approval from authorities.	Within 90 days of commencement date
9.	Obstructions.	Within 45 days of commencement letter
10.	Monitoring of Ground settlement & up level.	Along with the bid.
11.	Safety.	Along with the bid.
12.	Quality assurance/Central plan.	Along with the bid.
13.	Contractors Personnel	Along with the bid.
14.	Remedial measures.	Along with the bid.
15	Work schedule	Along with the bid

9.6 Products

9.6.1 Standards and Codes

Except as otherwise stipulated in this Specification, all materials and workmanship shall comply in all respects with requirements of such standard and specifications, codes and other standards issued by the Bureau of Indian Standards (BIS) and current at the date of bid as may be applicable to any part of the Works of this Contract. In the event there being no relevant Indian Standard Specification, other relevant standard, specification, current at the date of bidding such as the British Standards Institution (BS), American Society for Testing Materials (ASTM), German Standards (DIN), Japanese Standard for Water and Sewerage (JSWAS), and/ or of the or any other equivalent standard approved by the Engineer shall apply. If after the date of invitation to Bid there is an amendment to a standard specification relevant to the Contract, the Engineer will direct whether the amendment is to apply.

In the event of there being any conflict between this Specification, the Drawings and any Standard Specification forming part of this Contract, this Specification shall take precedence over the drawing, codes and other standards in that order of precedence. In any case, the Engineer's decision shall be final and binding on the Contractor.

9.6.2 Selection of Equipment

The contractors shall be responsible for the selection of a suitable micro tunnel boring machine capable of excavating the materials including soft marine clay with high water table, rocks and mixed ground that may be encountered along the route of the pipeline to be laid under the contract.

The Contractor shall be solely responsible for ensuring that geological and geotechnical information he obtains or possesses for the sites is adequate to accurately determine the types of soil that may be encountered during execution of the project. The contractor is deemed to have carried out sufficient geological and geotechnical investigation of the sites and testing of the soil as necessary at his own cost before the selection of the micro tunneling system.

Contractor shall be responsible for selecting suitable equipment for trenchless installation of the sewers capable of excavating all soil types which may be countered during the execution of the project.

The contractor shall also ensure that the system he selects for the project shall successfully excavate in the wide ranging ground conditions from clayey and sandy strata to mixed ground/ hard rock that may be encountered along the route.

Contractors shall pay particular attention, when selecting the tunneling/ boring equipment for the project, to ground water level fluctuation and the wide ranging subsurface soil strata from marine clays, sands, gravels, soft soils that may be present at the sites. The equipment selected for the project shall have appropriate cutter head equipped with suitable cutter bits to excavate all types of soil formations below the water table.

The tunneling/ boring equipment shall be capable of balancing the ground water pressure supporting the excavated tunnel face at all times. The equipment shall be articulated to enable remotely controlled steering, in both the horizontal and vertical directions. It shall be capable of preventing rotation and rolling movement of shield's body during the drive. The tunneling/ boring equipment shall, have the following features.

(a) Equipped with suitable steering and guidance system that ensures easy steering control (With arrangement for anti roll, or pitching/ dipping)
(b) Equipped with a suitable lubricating system arrangement
(c) Ability to provide for an Intermediate Jacking Station, as needed

(d) Instrumentation to measure deviation from the designed level and grade, rolling and pitching of the equipment, cutter torque and its percentage to the maximum torque, rpm, jacking speed, tunnel face pressure etc. preferably with a computerized data logging and printing facility.

(e) Spoil removal system (Slurry/ Auger system) capable of removal of excavated stuff by balancing the face pressure.

(f) The machine hall be manufactured by a reputed manufacturer having supplied at least one such machines during last five years in India and the supplied machines must have successfully carried out underground pipe installation work for a length of at least 500m.

The equipment proposed for the project shall meet the above mentioned criteria failing which it will not be permitted to be used in the project.

9.6.3 Jacking Pipes (RCC/ MS)

The pipes must be manufactured in a reputed pipe manufacturing facility using vertical vibration casting method having valid BIS license for manufacturing of RCC pipes from450mm to 1400mm (NP3/ NP4 Class) under IS 458.

Pipes manufactured by the contractor's themselves in a temporary manufacturing facility shall not be acceptable.
The pipes for jacking operation shall be precast reinforced concrete pipes manufactured by vertical vibration casting process only.

Design, manufacture and factory testing of the pipes and specials shall be to BS 5911 Part 120 or JSWAS A-2-1973 or other acceptable standard and shall meet the test requirement specified in I.S 458 (NP 4 Class) or its equivalent standard as amended up to-date . The grade of concrete shall not be less than M45 design mix. The clear cover of concrete over steel reinforcement on the wet side shall not be less than 25mm.

The jacking pipes shall be provided with Stainless Steel Collars fixed to the female end of the jacking pipe.
Each pipe shall be provided with a precision cut compressible packer to be attached to pipe end with approved adhesive. The Contractor shall also provide details of the compressible packer including its dimensions, Modulus of elasticity etc.

The outside and inside diameters of the pipe shall be such that they match the dimensions of the tunneling equipment or vice versa. The standard length of the pipe shall be 2.5m (Between 2.43m to 3.05m). However, the length of the pipe shall be shortened if desired by the contractor to suit the site conditions subject to the Engineer's approval.

The concrete used for jacking pipes shall be from a RMC plant. If the concrete for manufacturing pipes is produced at the plant itself, it shall be manufactured in an approved automatic batching plant. Complete details of the Batch of ready mix concrete like its Grade, WC ratio, maximum aggregate size, time of leaving the RMC plant, time of pouring into the moulds, additives and suppliers certificate shall be maintained for each batch. Three cube samples shall be taken from each RMC batch and tested for 28 days strength in a laboratory approved by the Engineer. If the test cubes fail the requirement, the finished pipe shall be liable for outright rejection after NDT (Schmidt Hammer Test or any other as directed by the Engineer).

The Engineer's representative shall have full authority to inspect any material or finished product and reject the same if not found conforming to the standards. The Contractors shall make his representative

available to the Engineer's representative during such inspections and testing failing which the Engineers representative shall be at liberty to take ex-parte decision, which shall become binding upon the Contractor.

The pre-cast reinforced concrete pipes shall be sufficiently reinforced with steel to withstand all stresses induced by handling, jacking, earth and water pressures and all working loads at the depths at which they are to be used without cracking, spalling or distortion. The pipes shall be of at least strength Class NP4. A load factor (for the maximum jacking force) of not less than 2.0 shall be used in the calculations to determine the strength of the pipes required. The strength of the pipes shall be tested by the three-edge bearing test. When subjected to the design load in such a test, the load required to produce the crack width of 0.25mm on the pipe shall be in accordance with IS Code 458. All such tests shall be carried out at the expense of the Contractor. The frequency of the Three Edge Bearing test shall be at least once in 3 months or every 100 pipes or part thereof for each diameter.
When designing the jacking pipes, the contractor shall take into consideration jacking load including eccentric loading, pipe stiffness, corrosion resistance, flexibility, durability, joint efficiency etc.

The Contractor shall take precautions to minimize the resultant pipe stresses in a jacking pipe and to achieve a trouble free jacking operation. The eccentric loading shall account for maximum steer ability.

The Contractor shall submit full details of his proposals for the pipes, giving detailed drawings showing sizes, reinforcement and type of joints, calculations, together with the name of the proposed manufacturer, the place of manufacture and the manufacturing process to the Engineer for approval along with a consent letter from manufacturer of the pipes from such manufacture as well as the RMC supplier.

A detailed record (signed jointly by the Contractor's and Engineer's Representative) of concrete batch, its 7 day and 28 day strength, weight of reinforcement cage, weight and dimensions of the collar etc. shall be maintained for every pipe manufactured for use in the works.

Every pipe tested for the three Edge Bearing Strength shall also be tested for ultimate (crushing) test in presence of the representative of the Employer or PMC and/ or Third Party Inspection Agency. The pipe to be tested for three edge bearing test shall be randomly selected by the Engineer or any designated agency. At least one pipe in 200 pipes for each diameter must be tested for three edge bearing test outside the manufacturer's factory in a test facility as directed by the Employer. The test set up and the gauges shall be properly calibrated with a certificate from an agency authorized to do the calibration of equipment. The pipes shall meet the requirements of the Standards for Jacking pipes like JSWAS/ BS or any other acceptable standard but the requirements of strength and other tests like hydraulic and permeability shall be in accordance with IS 458.

All workmanship and materials used in the manufacture shall be subject to the approval of the Engineer who shall be authorized to inspect materials at source and the manufacturing processes in the factory at any time.

Proper curing arrangement in the form of water spray curing, steam curing or chemical curing as approved by the Engineer shall be provided.

(a) Pipe shall be straight and uniform with square ends. The joints shall be well formed to allow efficient transfer of jacking load from pipe to pipe
(b) Pipe joint shall be fitted with compressible packer for better distribution of jacking load.

(c) The jacking frame, jacks and steering head shall be properly aligned along the designed alignment and grade and the whole assembly shall be square and at right angles to the thrust wall

Steering corrections shall be made gradually to minimize abrupt misalignment angles between the pipes

The pipes should be provided with well-formed arrangement for groove for rubber gasket.
The pipes shall be internally lined with "T" rib type HDPE sheet lining as corrosion barrier (2 to 3mm thick) installed while casting of the concrete pipe.

The pipes shall be sufficiently cured (Minimum 28 days if wet cured with water spray or as approved by the Engineer is cured with steam or by application of chemicals) before they are dispatched to the works sites and used in the jacking process. They shall be handled with extreme care to prevent the edges of the pipes from chipping. The pipes shall be stacked in shade or adequately protected from severe sunrays. The Engineer may reject any pipes he considers not suitable for the Works and these rejected pipes shall be removed from the site immediately. After factory testing and before dispatch, every pipe and special shall be marked in accordance with the Standard used. In addition, each pipe shall be marked with a number corresponding with the order of manufacture and date of manufacture and Grade of Concrete. Test certificates from the manufacturers or other relevant authority shall be submitted to the Engineer.

The pipe manufacturing and testing process shall also be subject to Third Party Inspection. Pipes shall not leave the manufacturer's facility unless they are released by the TP agency/ PMC/ the Employer.
The sites may have limited or restricted storage space for stacking of jacking pipes. The Contractor shall therefore schedule the supply of pipes to the sites in such a way that only absolute minimum numbers of pipes are brought to the site at a time.

In case of MS jacking pipes, the pipes shall be manufactured and tested in compliance with IS 3589 and shall be provided with liquid epoxy coating/ lining system as per ANNEX B of IS 3589.
Carrier pipes shall comply with the relevant IS Standards.

9.6.4 Pipe Joints (RCC and MS)

The jointing arrangement for the jacking pipes is crucial in terms water-tightness, flexibility and smooth transmission of jacking force. Spigot ended jacking pipe with recess to receive rubber rings and stainless steel/ Mild Steel couplings (collars) or other acceptable joints shall be used in pipe-jacking application. The spigot and socket joints shall be flush from outside as well. The contractor shall submit joint details to the Engineer for approval.

The joint rubber rings supplied and installed shall be of the Cornelius rubber ring type or similar approved and shall be capable of accommodating 2 degree deflection at each joint. Joint rings shall meet with the latest edition of I.S 5328 and B.S 2494 part 2 or be of approved quality by the Engineer.
The properties of the joint ring shall be between those specified in BS 2494 for grade D and grade B.
The testing of rubber ring shall conform to IS. 3400 and also IS. 5382.

The Contractor shall indicate the grade of rubber rings he intends to use and submit samples for approval prior to incorporation in the Works. The grade, type or source of supply of rubber rings shall not be changed without the written approval of the Engineer.
MS pipes shall be with welded joints as per IS 5822

9.6.5 Pipe Couplings (Collars for RCC jacking pipes)

The pipes shall be provided with **Stainless Steel (SS 304 Grade) Collars.** The arrangement shall be of such dimension and thickness so that when inserted into the pipe, it fits exactly into the recesses in the pipe. The joint so formed shall be watertight. The joint details shall be approved by the Engineer. The thickness of collar shall not be less than 8mm.

9.6.6 Compressible packers

Appropriate compressible packers shall be used at the joints for distributing the jacking force evenly through the wall of the jacking pipes. Uneven transfer of jacking force from a pipe to another shall result in concentrated and excessive stresses in the pipe which can cause the pipe to crack. Contractor shall submit details of the compressible packers for Engineers approval.

9.7 Identification of pipes, rubber rings etc.,

Every pipe made shall be clearly and indelibly marked upon it unique identification number, class, batch of concrete, diameter and date of manufacture. (Suggested format: FACT_NAME /DDMMYYYY/Mxx/BATCH_NO/ NNN) Every finished pipe shall be tested for dimensional conformity and non-destructive testing with Schmidt Hammer or any other method as approved by the Engineer. Full records are to be maintained of each pipe test and for each individual pipe the date manufactured, cleared after testing and supplied on site.

The Contractor shall make arrangements for visits of the Engineer's representatives for inspection and 3 EB testing as and when deemed necessary by the Engineer. All expenses in connection with such visits shall be borne by the Contractors. After the satisfactory completion of testing and approval of the pipes by the Engineer the pipes shall be stored at factory premises during the period awaiting delivery.

No pipe shall leave the manufacturer's yard for the site unless it is tested and cleared by the Engineer's representative and the Third Party Inspection agency appointed by the Engineer/ PMC.

9.8 Tests on Jacking Pipes

Factory Tests

One pipe out of every 100 pipes or part thereof manufactured for each diameter shall be tested for Three Edge Bearing Test in the factory or a laboratory or institution approved by the Engineer at the Contractor's expense. Besides this at least one pipe in every 200 pipes shall be tested outside the factory in a facility as directed by the Engineer. The pipe for testing at a test facility outside the manufacturer's factory shall be selected at random from the pipes delivered at site. All expenses in connection with transportation to and fro, loading/ unloading, ant taxes/ fees etc shall be borne by the contractor.

Every RCC jacking pipe shall be subjected to following dimensional conformity tests and the tolerance shall be within limits as indicated below -

1. **Length**

Pipe Dia in mm	Tolerance for all types of pipes in mm

Above 1200	+25

2. Perpendicularity of faces

Pipe Dia in mm	RC Jacking pipe
Above 1200	8

3. Deviation from straight

Pipe Dia in mm	Tolerance for all types of pipes in mm
Above 1000	±10

4. Deviation from pipe d

Pipe Dia in mm	Tolerance for all types of pipes in mm
Above 1000	+0, -16

9.9 Execution

9.9.1 Information for the execution of works

The works under the scope of trenchless technology shall have to be carried out using approved trenchless technique.

The Contractor shall be responsible for inspecting the sites and familiarizing himself with the conditions under which the work will be performed and with all necessary details including geotechnical conditions and buried services as well as the physical conditions, tidal impacts etc. as to the orderly and successful execution of the work. The omission of any details shall not relieve the Contractor of full responsibility for the satisfactory installation of the work in its entirety. No monetary or other claims made by the Contractor on the grounds of want of knowledge will be entertained by the Engineer.

Plans and details of the equipment, materials and the method of construction to perform and complete the work shall be submitted by the Contractor for approval of the Engineer before commencing these operations. Approval by the Engineer shall not relieve the Contractor of his sole responsibility for the efficiency, reliability, and soundness of the method employed in completing the work in a satisfactory manner.

The Contractor is advised that it shall be his sole responsibility to ascertain for himself the extent of work that is required to be done in site and to generally obtain his own information on all matters affecting the execution of the whole of the works involved in this contract to the entire satisfaction of the Engineer. No claim of extras in consequence of any alleged ignorance in any aspect will be entertained by the Engineer. It must be clearly and definitely understood that the contractor shall be held solely responsible for making all necessary arrangements and coordinating with all relevant Authorities, Specialists, Sub Contractors, etc., to ensure satisfactory and timely completion of this contract.

9.9.2 Execution of works-General

The Contractor shall be fully responsible for the design and construction of the jacking/ launching and receiving pits, thrust wall, installation of jacking equipment, installation of any other equipment, sheeting/ shoring, bracing, etc., and for the efficient execution of the work.
The Contractor shall be required to monitor closely the progress of the trenchless operations. Daily manual logs or site records of thrusting pressures, torque, bentonite injection rate and the line and level measurements shall be properly maintained in addition to any computerized data logging and shall be available to the Engineer's representative at all times. Such records shall be duly signed by the Contractor's site in-charge. If the Contractor fails to maintain and produce such details before the Engineer's representative on site, the Engineer's representative may order suitable steps including suspension of the work without prejudice to any other rights of the Engineer. The Contractor shall be solely responsible for such actions ordered by the Engineer's representative.
It is the responsibility of the Contractor to ensure that the completed pipelines are watertight. If leakage occurs before completion or during the maintenance period, the Contractor shall carry out any remedial work that may be necessary to make the Works watertight all at his own expense.

9.9.3 Location and verification of buried services

The Contractor will be held solely responsible for making his own investigations of any buried services in the vicinity of the Works and to protect them from getting damaged due to his work. Contractor shall be deemed to have allowed for any extra costs in his rates for detecting all obstructions and buried services including appropriate measures to protect the services and temporarily divert the same in consultation with the concerned agency with its prior approval regardless of whether they are indicated on the drawings or not. It shall be the Contractor's responsibility to obtain any permission from such agencies. The Engineer/ Employer may issue necessary recommendation letters to the concerned utility agencies if required.

The contractor shall engage at his own cost a competent service detecting professional or agency who shall have state-of -the -art detecting equipment to locate and verify all the buried services such as pipeline, water, telecom, electricity, gas and all other services, and abandoned services and structures well ahead of commencing the works.

The detector shall be able to receive narrow signal responses from metallic or non-metallic buried services in order to pinpoint the position and direction of the services. It shall also be able to pick up the position and direction of different services in congested area and detect the buried services regardless of almost any environmental interference.

Combination of Ground Probing Radar (GPR) and Electromagnetic Location (EML) testing shall be used for locating the underground utilities and buried objects. The lines tested using GPR and anomalies located using EML shall be topographically surveyed using a Total Station / Theodolite at the same time as the geophysical testing is carried out.

The information so collected shall be submitted to the Engineer after getting it confirmed from the respective agency. It shall be clearly understood by the Contractor that no work shall be carried out without locating all the buried services and he will be held solely responsible for any consequential expenses and delays if he ignores this specific requirement or fails to locate any services along the route.

The Contractor shall take every precaution that in the opinion of the Engineer and as advised by the owner of the utility is necessary for the protection from injury of all existing and proposed water, drain, pipeline and other pipes, electric and telephone conduits, and other existing works, roads and

services wherever encountered or which are adjacent to the works, and to maintain the same until in the opinion of the Engineer the general progress of the work renders further protection unnecessary. All damage occasioned by the Contractor to these works and services shall be repaired at once at the Contractor's risk and cost, as directed by and to the satisfaction of the Engineer.

9.9.4 Site investigation

The Contractor's site investigation for trenchless works in general shall be critical and the most important engineering work to be carried out before commencement of work on site. The contractor shall clearly understand the importance of establishing the subsurface ground conditions and their range of variability along the pipeline route well before embarking on the actual works. There should not be any room for unforeseen ground conditions and it is absolutely necessary for the Contractor to know what is to be encountered during the tunneling operation. The contractor shall be deemed to have accurately established the types of soil and rock strata along the tunnel bore and their range to enable him to select the equipment / machines and to set-up and operate correctly.

9.9.5 Subsurface investigation

The subsurface investigation shall includes study of all existing geological and geotechnical information for the area including the information pertaining to the project and the location maps of all the services in the area from the utility companies/authorities for initial planning. Data on abandoned and existing obstruction, foundation, piles and the structures in the vicinity of the alignment shall be also collected. Field survey using utility services locator and trial trenches may also be carried out to verify the location of the services and obstructions.

Mapping out of the subsurface soils/rock profile along the pipeline alignment and locating underground utilities and buried objects by geophysical testing. Investigations may include documentary survey; bore logs, geophysical investigations, in situ & laboratory soil / rock tests. Various geophysical investigations include but not limited to Ground Probe Radar (reflection of electromagnetic waves), Radio Magnetotellurgy (measurement of resistivity in electromagnetic field of a radio transmitter), Electrical Method (measurement of apparent resistivity by injection of direct current and measurement of potential difference), Seismic Refraction (refraction of seismic waves on layers at speed increasing with depth), Seismic Reflection (reflection of seismic waves on contrasting interfaces), Microgravimetry. (local variation in gravitational field to detect cavities)

The Contractor is deemed to have allowed for any extra costs in his rates and to be aware of similar state of the art ground probing/mapping technology currently available on the market and to have made provision for its use in the project as part of his subsurface investigation works.

The contractor shall be deemed to have in possession of all the information and data required to accurately evaluate the subsurface conditions before commencement of any works.

9.9.6 Geological and geotechnical evaluation

The Contractor is deemed to have obtained, studied and evaluated all the geological and geotechnical data for the sites including any data if available with the corporation for the sites and made his own judgment and conclusion on the types of soils and rock to be excavated along the pipeline route. The Contractor must supplement this information possessed by him with appropriate geotechnical investigation prior to selection of appropriate micro tunnelling/ drilling machinery upon award of the work.

The applicant shall inform him thoroughly and make his own deductions as to the nature of the materials to be excavated; the difficulties of making and maintaining the required excavations and of doing other work affected by the geology of the Site and shall accept full responsibility thereof.
The Contractor shall carry out exploratory boreholes as deemed necessary by him and conduct laboratory testing as necessary for a micro tunnelling project. This information shall be supplemented with tests such as soil resistivity tests and seismic refraction test to provide complete information about the stratigraphy in connection with the proposed works.

It shall be obligatory for the contractor to prepare a geotechnical profile along the alignment showing the proposed sewer line superimposed thereon to indicate strata anticipated. The contractor shall also detect and plot the buried services on the topographic survey map indicating their position in plan as well as approximate depth below GL.

However, this does not absolve the contractor from his responsibilities for successful completion of the work.

9.9.7 Bore logs and ground probing

Sufficient numbers of boreholes shall be taken by the Contractor. The Contractor should submit Geotechnical profile along the route of the pipeline and buried services data for the entire alignment per the schedule for submittals.

Continuous sampling shall be resorted to over at least 2xDia above the crown of the pipe and 2x Dia below invert of the pipe to be laid.

The Contractor shall collect soil/ rock samples at the level of the proposed pipeline in presence of the Engineer's represent and get the same tested for sieve analysis, cohesion, angle of internal friction, ground water level, Unconfined Compressive Strength (UCS), abrasivity etc. at any laboratory approved by the Engineer. Samples taken in absence of the Engineer's representative and tested in a laboratory not approved by the Engineer shall not be valid for determination of the any parameters.

9.9.8 Groundwater investigation

Ground water condition is one of the critical data required when selecting the trenchless technology system. Ground water affects the safety of the excavation face, start and exits of the tunneling/ drilling equipment from the shafts. Uncontrolled extraction of water from the surrounding during excavation can affect the adjacent structures. Piezo-metric pressure, water leakage, ground water level and etc., shall be carefully checked before and during microtunnelling/ drilling/ boring works.

9.9.9 Ground stabilization/ improvement

It shall be the responsibility of the Contractor to maintain stable soil conditions at the jacking face to prevent loss of ground above the jacking operation and movement of the surrounding earth or to prevent diving of the machine and sinking of pipes. The methods of maintaining face stability and preventing ground movement and subsidence shall be by means of fluid slurry or earth pressure applied to the tunnel face. Alternatively, unstable ground ahead of the jacking face may be stabilized by the injection of suitable chemicals. Methods which require dewatering of the ground will not be accepted, nor will methods which may lead to significant ground loss.

Movement or settlement of structures, utilities and pavement shall be monitored by the Contractor during the trenchless operation and reported to the Engineer and concerned authorities.

The Contractor shall make provision to install peizometers, settlement plate etc., in his rates for pipe installation if movement or settlement occurs, which in the opinion of the Engineers may cause damage, the Contractor shall take immediate action to prevent further movement, settlement or damage. The Contractor shall repair at his risk and cost any damage and restore structures, and pavements to the satisfaction of the Engineer. The contractor shall pay expenses if the owner or concerned agency or any Third Party elects to carry out such repairs by themselves.

9.9.10 Setting out

The Contractor shall be deemed to have thoroughly examined the sites, the location of the buried services, availability of space for footprint, access to sites & etc., and adjusted the pipeline alignment as deemed necessary and obtained approval of the final pipeline alignment from the Engineer before commencement of the setting out. He shall set out and mark on the ground the proposed pipeline route and the locations of the jacking and receiving shaft and the area they occupy for the Engineer's inspection and approval.

The Contractor shall be solely responsible for the accuracy of the setting out and any expenses or delays arising from errors made in the setting out shall be borne by the Contractor. Any consequential work or abortive work carried out by the Contractor to rectify the errors shall be entirely borne by the Contractor.

9.9.11 Site layout

The working space at the sites is often restricted and hence the site layout has to be planned carefully in advance to set-up the equipment and accessories.

9.9.12 Construction of Jacking and Receiving Shaft

The excavations for Jacking or Receiving shafts may be used for construction of manholes inside them provided proper branch connections as directed by the Engineer are cut in the wells sunk for shaft. The Contractor shall submit to the Engineer for approval dimensioned drawings and calculations of the timbering or trench sheeting details for the shafts. Each shaft shall have a separate ladder bay for access which shall be isolated from the part of the shaft used for hoisting materials. The shaft trenching shall be watertight and shall prevent any pressurized slurry from the tunnel face reaching the shaft.

Soil improvement methods that can be used include grouting, ground freezing, and dewatering. If the ground consists of unstable soil, the same may be stabilized by vibro / dynamic compaction, by compressed air for sandy soils and by ground freezing, preloading, lime treatment for clayey soils. In certain instances, ground treatment or groundwater management methods may be required to enable the construction of the shaft to proceed. These include well pointing and deep wells, Compressed air, Suspension grouts, Chemical stabilization, Ground freezing.

There are various shaft construction method alternatives, Liner plates, 2-flange steel liner, horizontal metal sheeting, sloping or battered excavation, trench boxes, slide railing system, soldier piles with timber lagging, soldier piles with steel lagging, steel / concrete / RCC sheet piles, CMP shafts, concrete sinking shafts, precast concrete segments, concrete slurry walls, Pre-cast or cast in- situ caissons, Rock anchorage rods and tensioned rock bolts, metal straps, un-tensioned steel dowels, Wire mesh with guniting and ground freezing. No extra payment shall be claimed by the contractors for carrying out soil improvement / stabilization, or shaft shoring techniques as mentioned.
The Contractor shall submit the design and construction details of all Temporary Shafts and their proposed locations along the tunnel alignment to the Engineer for acceptance. The submission shall also include details on shoring system, entry and exit arrangement, thrust wall layout and design

details, general layout of guide rail and jacking table arrangement etc. Temporary Shaft drawings are to include but not limited to:

1. Launch/jacking and reception shaft configurations.
2. Design and construction of launch/jacking and reception shaft.
3. Details for excavation and backfilling procedures, ground support systems, and ground stabilization if required.
4. Special requirements for jacking and receiving shaft penetrations, thrust blocks, backstops or other reactions required for Microtunnelling/ pipe jacking/ auger boring, casing pipe jacking or any other jacking.
5. Full calculations supporting maximum jacking capacity that jacking shafts will withstand
6. Dewatering and ground water control plans for all temporary and permanent shafts.

The shaft shall be kept dry at all times and shall have a drainage sump to pump out the ingress water. The Contractor is deemed to be fully aware of the serious consequences to the tunneling equipment and other accessories if the shaft is flooded. He shall take every precaution to avoid flooding in the shaft the shaft shall be well protected against surface runoff getting into the shaft. The contractor shall be solely responsible for any consequential delays and expenditure arising as a result flooding the shaft.

The shaft floor shall be designed to withstand the tunnel machine and other accessories.
The Contractor shall be solely responsible for providing and subsequent removal of shoring to the shafts or pits and ensuring stability of the sides of such excavations and safety of adjoining structures.
The sizes of the shafts shall be kept as small as possible considering site constraints. Equipment manufacturer's data on required shaft sizes shall be furnished to the Engineer along with the bid. The sizes of pits shall take due cognizance of available space needed for jacking frame, shoring or feed pumps or other ancillary equipment, thrust wall and entrance ring.

Considering the ground and physical conditions at site, the shafts may be constructed using well sinking method as preferred method. The contractor shall be solely responsible for design, erection and maintenance of the caisson shafts constructed by him using well sinking.

9.9.13 Construction of Thrust Wall

Thrust wall shall be designed and constructed by the contractor to the approved details. The thrust wall shall be reinforced or unreinforced concrete constructed against the wall of the jacking shaft. The Contractor shall ensure that the thrust wall is constructed as an independent structure and it shall not interfere with the jacking shaft or the floor when jacking force is applied on to it. Contractor shall indicate in his submittals the construction details of the thrust wall showing details on how the wall be made independent of the jacking shaft structure.

The Contractor shall ensure that the thrust wall and the soil behind are in complete contact and there is no gap between them. The contractor shall further ensure that the thrust wall shall effectively transfer the jacking force on to the soil behind and that the ground behind is capable of withstanding the jacking force.

In the event that there is gap between the thrust wall and the soil behind, the Contractor shall arrange the gap to be filled with approved cement grout before loading the thrust wall.

9.9.14 Installation of Guide Rails/ Jacking frame

The Contractor shall design and fabricate the guide rail / Jacking frame in accordance with the equipment manufacturer's details and install it firmly onto the floor of the jacking shaft. He shall ensure that the guide rail / jacking frame is installed to the correct grade, levels and alignment. It shall be also square to the pipeline alignment at all times and not disturbed due to forces arising from the jacking operation. He shall arrange with the Engineer's representative to check the level, alignment etc., of the guide rail and obtain the Engineer's endorsement before commencing guide the pipe jacking work.

9.9.15 Entrance and Exit Arrangement

One of the most critical operations is the launching and retrieval (entry and exit) of the micro tunneling/ boring machine. Often this process takes place well below the water table. In those cases, it is critical that the contractor implement adequate engineering measures including improvement of unstable soil by grouting or other means to prevent soil and water inflows into the shaft.

It is common practice to install a rubber seal at the entry and exit. The seal is to prevent the flow of ground water or lubricant (used for reducing the frictional resistance) through the shield/pipe entry opening on the shaft wall.

An exit ring must be provided without exception if the strata at the level of exit happens to be loose. The Contractor shall plan this work well in advance and fabricate the fittings and rubber seal as per approved method.

Machine exit in to the reception shaft will not be permitted unless the reception shaft is provided with proper exit ring.

9.9.16 Soil Improvement at the Tunnel Entry and Exit

In addition to the seal, it may be necessary to stabilize the soil behind the entrance wall. This is to prevent any free flow of unstable soils into the pit when opening is made for the shield to enter into the ground. Chemical grouting, cement grouting, jet grouting, piles, ground freezing or temporary shoring are some methods commonly used by the contractors to prevent the soil flow into the shaft.

9.9.17 Cement Grouting

The Contractor shall be fully responsible for preventing the occurrence of voids outside the pipe and if they occur he shall fill them with cement grout. Immediately following the jacking operation the Contractor shall pressure grout the jacked section to fill all voids existing outside of the pipe. Grouting shall be from the interior of the pipe through grouting holes as specified. The grout mix shall be at least of CM 1:3.

Systems of standard pipe, fittings, hose, and special grouting outlets embedded in the pipe walls shall be provided by the Contractor. Care shall be taken to ensure that all parts of the system are maintained free from dirt. Grout composed of cement, sand and other approved compound and water shall be forced under pressure into the grouting connections at the invert and shall proceed until grout begins to flow from upper connections. Connections shall then be made to these holes and the operation continued to completion.

Apparatus for mixing and placing grout shall be of a type approved by the Engineer and shall be capable of mixing effectively and stirring the grout and then forcing it into the grout connections in a continuous uninterrupted flow.

After grouting is completed, pressure shall be maintained by means of stop cocks, or other suitable devices until the grout has set sufficiently. After the grout is set, grout holes shall be completely filled with dense concrete and finished neatly without evidence of voids or projections.

9.9.18 Jacking System

The hydraulic jacking system shall be installed against a purpose built thrust wall in the jacking shaft. The jacking force required for jacking pipes and the tunneling/ boring machine shall be provided by high pressure jacks driven by hydraulic power packs with appropriate factor of safety. The ram diameter and stroke of the jacks may vary according to individual contractor's technique and to suite site conditions.

The jacks shall be mounted on specially made frames so that the jacks are square to the pipe alignment. The jacking frame shall be firmly supported to the floor so that it does not move during jacking operation. A push ring shall be used to transmit the jacking force evenly to the pipe.

There are jacking systems with multiple strokes or long stroke mounted on a specially made jacking frame available to push a full-length pipe in a single setting. The system does not require the use of spacers and hence a substantial increase in productivity can be achieved by using multiple stroke jacking system.

9.9.19 Jacking force

The Contractor shall calculate the anticipated jacking load for each micro tunnel/ pipe jacking/ auger boring drive well ahead of designing the jacking pipes. Accurate estimation of the jacking load is necessary to determine the pipe wall thickness, the need for intermediate jacking stations and lubrication requirements, types of jacking system and thrust block design. The overall jacking force depends on the type of surrounding soil, depth of cover, pipe materials, diameter and the overall length of the pipeline. The total jacking force essentially consists of two components, "Frictional force around the pipeline" and the balancing force at the tunnel face called "Face Pressure". The Contractor shall use appropriate geo-mechanics formulae and guidelines for computing the jacking force. The contractor shall calculate the anticipated jacking force for each drive and submit his calculation to the Engineer for approval.

The Contractor shall be solely responsible to ensure that the pipes are not subjected to excessive jacking force or torsional force so as to crush them. If such thing occurs the contractor shall have to remedy the situation at his risk and cost.

9.9.20 Pipe Lubrication System

The boring machines are commonly designed to overcut about 10mm (in some cases up to 20mm) around the external diameter of the pipeline. The pipeline can, in theory, be jacked freely through a fluid medium by injecting a clay based (bentonite) or polymer based lubricant into this annulus. In practice, however, fluid losses may occur into the surrounding ground. The contractor shall carefully monitor the jacking force and use appropriate lubrication system, to bring down the jacking force within the allowable jacking force for the pipe.

9.9.21 Protocol of each Drive

After completion of particular drive / work or as directed by the Engineer, Contractor shall submit within five days a proper & authentic `PROTOKOL' (both soft & hard copy) of Micro tunneling machinery for that particular drive / work, to the Engineer. Protocol must reflect date time, length, various pressures of main jacks, steering jack's extensions, and cutter head torque & face pressure, slurry & feeder pumps-flow rate, pump pressures, deviations in vertical & horizontal alignment, roll, pitch etc. No extra payment shall be admissible for this requirement.

9.9.22 Special Traffic Precautions

The Contractor's attention is specially drawn to the requirements by the traffic police and road authorities and Specifications regarding Traffic Control, Access and the Reinstatement of road surfaces etc. It shall be the responsibility of the contractor to obtain permissions from traffic police and other authorities well in advance of the commencement of the works.

The Contractor's progress/ programme and road opening schedule must be arranged in details for discussion with the Engineer and the Traffic Police. The laying of pipelines must be broken into appropriate sections and where necessary special traffic diversions arranged.

Whenever carriageways are affected, the Contractor must arrange to contain the works within the narrowest possible area. Excavated material must be removed as the work proceeds or contained within the areas designated by the Engineer/ Traffic Police.

The Contractor shall carry out the work in such a manner as to cause minimum interference with the public use of highways, footpath and other thorough fares.

All workmen working on roads are required to wear approved retro-reflective vests at all times.
The Contractor shall include in his rates for compliance with all the conditions stipulated above.

9.9.23 Road Opening

Where manholes have to be constructed on existing metalled or concreted road, the Contractor is required to submit a detailed road opening schedule to the Engineer for approval.

The Contractor shall contain the works within the narrowest possible area when laying pipelines along metalled or concreted road.

Traffic flow must be maintained at all times along the roads affected by the work. Sufficient lighting, road signs, barricades and traffic diversion signs must be established along the sites of the works in accordance with the Traffic Police requirements and to the entire satisfaction of the Engineer.

The Contractor shall also comply with the conditions imposed by Traffic Police and Roads Opening Conditions and Requirements stipulated by any other Authority.

Upon the completion of the pipeline or manholes, the Contractor shall backfill and make good all disturbances to the road, side table, road kerb and drains to the satisfaction of the Authorities and the Engineer.

If required the pits shall be covered with decking plates with appropriate support so that all traffic shall be allowed to run over the decking. No extra payment shall be admissible for such arrangements and the contractor's rates shall be deemed to cover such requirement. If directed by the authorities or the Engineer, the Contractor shall construct temporary diversion roads at his own cost to allow the traffic to flow through during the construction.

9.9.24 Partial Covering up of Road in Busy Areas

Where it is unavoidable to locate manhole shafts or working shafts for tunnels in busy roads, the top of the openings shall be covered by decking, leaving only the minimum required area open at the top to carry out work within the shaft. Vehicles shall be permitted to travel over such covers provided. The Contractor shall submit to the Engineer details of the partial covering. He shall allow for compliance of this requirement in his rates.

9.9.25 Reinstatement of Road and affected Surfaces

The Contractor shall carry out the reinstatement of road foundation and road surface in accordance with the Specifications and requirements of the Engineer and as stipulated in the contract specifications. This shall include machine-paving as and when directed by the Engineer. Where road markings are affected, the Contractor shall reinstate with thermoplastic instead of paintings to the satisfaction of the Engineer.

9.9.26 Safety

The Contractor shall provide adequate ventilation and efficient apparatus to keep all excavations, tunnels and pipelines free from all dangerous gases, whether generated in the soil strata or otherwise, and he shall take precaution to ascertain that they are in a safe condition before allowing his workmen to descend.

While working in existing pipeline or manhole, the Contractor shall provide air blowers to ventilate the place as sewage gas usually contains a high proportion of hydrogen sulphide, methane and other toxic gasses which in combination with oxygen is explosive. Approved gas monitors/detectors and oxygen meters shall be used to ensure that the place is free from all dangerous gases. The Contractor is required to appoint a Health and Safety Engineer (Accident Prevention Officer) to ascertain that the pipeline or manhole is in a safe condition before allowing his workmen to descend and work. No smoking or naked flame shall be allowed in the pipeline or manhole. Monitoring of the air quality shall also be carried out regularly by the Contractor's supervisor while work is in progress and work shall be immediately suspended should unsafe conditions develop.

The Contractor is warned that besides performing any work in existing pipeline or manhole, connecting to or breaking into existing pipeline or manhole also poses potentially hazardous conditions. The existing pipeline or manhole to which connection is to be made should therefore be thoroughly ventilated and certified as safe by the Supervisor/ Safety officer before workmen are allowed to execute the connection.

The Contractor and his Supervisor/ Safety officer shall be solely responsible for safety of persons entering in to the pipelines or confined spaces like manholes/ pits.

9.9.27 Continuous working

If, in the opinion of the Engineer it is necessary, by reason of the safety of the works, or the restoration of interrupted services or for any other reason whatever, the Contractor shall, when so ordered carry out the works or any portion thereof continuously by day and by night without extra charge and allow for such a contingency in his Bid price.

It shall be clearly and definitely understood by the Contractor that no claims in respect of any of the above shall be allowed in the settlement of the Final Account.

9.9.28 Steel trenching works

Wherever the sub-soil conditions are expected to be of a soft and unstable character, the normal methods of timbering may prove insufficient to prevent subsidence of the adjoining road surfaces, drains and canal and other services or adjoining buildings and structures, in such circumstances the Contractor will be required to use steel trench sheeting or steel sheet piling adequately supported by timber or steel struts, walling, etc.

Steel sheet piles shall conform to the provision of I. S 2314 or B.S. 4360 and shall be driven where required as directed by the Engineer.

The Contractor will be required to design the layout of the piling and the overall dimensions of the excavation to suit the sheets and corners available and to give sufficient working space for the proper construction of the work.

The Contractor will be expected to supply, pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the Specification and the terms “timber” or “timbering” shall also apply to steel trench sheeting or steel sheet piling throughout.

Alternatively, the Contractor may use trench boxes capable of supporting the ground in the given conditions. However, no extra payment shall be made on this account.

Contractors shall be solely responsible for design, installation and removal of any shoring or timbering or sheeting system and their adequacy and safety. The rates quoted by the Contractors shall be inclusive of such measures of providing steel sheeting or sheet piling.

9.9.29 Sewage in the connecting sewers

The pipelines installed under this Contract are meant to connect to the existing functioning upstream and downstream functioning sewers. These pipelines are carrying sewage (stagnant or flowing) and may also be in surcharged conditions at times.

9.9.30 Connection to existing sewers

The Contractor shall note that the connecting pipelines/ branches might have been laid sometimes back and would be full of stagnant sewage/ water and might also have some unknown connections. The methods adopted by the contractor for making connections of such lines shall take due cognizance of such circumstances as no extra payment shall be made on such account.

The Contractor shall note that in connecting pipelines to existing sewers, every care shall be taken to ensure that the connections are watertight and the existing pipelines are not damaged. Special precautionary measures shall be taken to ensure the stability of the pipelines connected to them.

The Contractor shall ensure that there is no interruption to existing flows during the connection works. No debris shall be allowed to fall or be discharged into the existing pipelines or manholes. Any debris which falls into the existing pipeline/ manholes and any obstructions thereby caused shall be removed at the Contractor’s expense immediately.

All connection to existing pipelines shall be subject to water tightness test and must meet the requirement for the same.

It shall be noted that during connecting the newly laid sewer line to the existing sewer, or for connecting cross sewers to the newly laid sewer, or to repair existing sewer, the contractors shall make necessary arrangement at his own cost, to procure Pneumatic plug / Inflatable plug / mechanical plug / Pillow plug for plugging existing sewer line. Plugging existing sewer by using mud / sand filled gunny bags will not be permitted. Plugging shall be done in co-ordination with & as directed by concerned staff of Main Sewer Dept of BWSSB.

Safety measures for use of Sewer Plugs - Contractors need to ensure that the sewer plug is inspected prior to each use. The plug shall be partially inflated and inspected under low pressure for any obvious wear, tear, cuts, abrasions or damage. Also, examine the accessories with which the PLUG is to be inflated.

Inflation pressures as in the Manufacturer's instruction manual and on the plug, must be adhered to when inflating the plug, but never exceeds the max. Working pressure. Check the internal pressure in the PLUG regularly.

Utilizing an air line extension plugs can be inflated from a distance, away from the danger zone or outside

The PLUGS shall only be used by persons who have been properly instructed and who are trained for the use.

When using the PLUGS, the safety of the user and any bystanders must always be borne in mind, as wrong use can cause life threatening situations.

Contractors shall consider measures to brace for and absorb the impact of plug failures and to prevent the PLUG from sliding out. This may include anchored ropes/cables in upstream manholes, bracing in the chase of the plugged manhole, or a combination of methods, all with associated risk assessments and controls in place.

Ensure only the use of approved and calibrated pressure gauges. And also ensure pressures are monitored and controlled during plug inflation / deflation with calibrated gauges.

The Contractor shall allow for all the above in his rates.

9.9.31 Laying pipelines in residential areas

The Contractor shall note that if the pipeline has to be laid in close proximity to existing premises. He shall take all necessary precautions, including the provision of steel sheet piling cut-off walls where necessary, to prevent any damage to the existing premises and shall be responsible for the damage and complete repairs of the same.

The Contractor shall be responsible for obtaining permissions from the owners of private premises if needed by him for his work. He shall be responsible for restricting his workmen to the site of the work while working in private premises. If the Contractor considers it essential to have additional working space he may obtain the same from private property owners entirely at his risk and cost. The Engineer is not bound to arrange for such facilities from private property owners.

Temporary fencing shall be erected as directed by the engineer to separate the worksite from the rest of the private premises at the Contractor's own expense for all execution.

Turf, walls, slopes, fencing, shed or any other structures whether directly or otherwise disturbed or damaged by the construction work shall be reinstated to the original conditions by the Contractor at his own expense.

The Contractor shall allow in his rates for complying with these requirements as no claim to the contrary will be entertained by the Employer/ Engineer.

9.9.32 Hydraulic testing of Sewer line & Handing over of completed works

Upon completion of works the sewer lines including rising mains shall be hydraulically tested as per the required head/ pressure as per CPHEEO manual provision of specifications. After successful testing, the contractors must clean the site as per the satisfaction of the Engineer and the same shall be handed over by the contractor to the user department under proper acknowledgement and certificate to this effect.

Hydraulic testing and cleaning up the site on completion is to be done by the contractors at his own cost and no extra payment shall be admissible for this requirement.

All works to be water tight

(a) The drains, manholes and all joints of pipes must be made thoroughly sound and water tight, and any joint which may be proved to be leaky at any time during the progress of the works or during the contractors' subsequent period of maintenance shall be immediately made sound by the contractors at their own expense. The contractors, when required by the Engineer shall at their own cost prove all works to be water tight by filling it with water to such height as the Engineer may determine. Any additional precautionary measure or appliances that may be found necessary to ensure the water tightness of the manholes, flush tanks, disc plug in junctions and the joints of pipes shall be adopted by the Contractor without extra charge, the responsibility of making them completely water tight resting upon the contractors.

Complete sewer inspection of inside of pipe shall be carried out with help of CCTV sewer inspection camera and a record of the same shall be maintained in the form of CCTV footage with proper indexing/ subtitles/ overlays etc and submitted to the Engineer (3 copies) on DVDs..

(b) Immediately after the CCTV pipe inspection has been completed and any defect discovered therein has been made good the Contractor shall prove the joints of the stretch of under-ground carrier pipes, to be water tight by filing in pipes with water before filling in the trench to the level of 1.50 M above the top of the highest pipe in the stretch and heading the water up for the period of one hour or such further time as the Engineer may direct. The apparatus used for the purposes of testing shall be approved by the Engineer. The contractor if required by the Engineer shall make the excavation dry and keep it so during the period of testing. No test applied to part of a stretch of pipes shall be considered conclusive nor shall it be deemed to obviate the necessity of an application of the test to the whole of stretch when completed. The loss of water (ex-filtration) or rise in water volume (infiltration) over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes and noting the quantity required to maintain the original water level. For the purposes of this test the average quantity added should not exceed 1 litre/hour/100 linear metres/10 mm. of nominal internal diameter.

Works not within above specified requirements shall stand rejected and shall be rectified by the

Contractor at his risk and cost.

The manholes when they have been raised above the highest subsoil water level expected in the monsoon shall similarly be tested for water tightness as for the pipe lines. The procedure for this shall be as follows:-

The mouths of all pipes entering the manhole shall be suitably plugged with brick, masonry or wooden or any other type of plug. The manhole under test shall then be filled with water up to the general sub-soil water level and observed for a period of one hour. If the level does not drop by more than 50 mm. in one hour it shall be assumed that the manhole is water tight.

Note for pipe laid by open trenching only: During the period of the test the outside trench shall be kept free from any accumulation of subsoil water in case of a drop of more than 50 mm in the water level the contractor shall note the places from where the leakage is taking place & take steps to stop the leakage.

(c) Cleaning of the pipes

The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

(d) If as a result of the removal of any obstruction the Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the length to be retested at the expense of the Contractor. Should such retest prove unsatisfactory, the contractor shall at his own expense amend the work and carry out such further tests as are required by the Engineer.

(e) It shall also be ascertained by the Contractors that each stretch from manhole to manhole is absolute clear and without any obstruction by means of CCTV inspection of the interior of the pipe line.

All works to be clear, clean and perfect

The contractors shall after completion or whenever required by the Engineer, prove all pipes and fitting to be clear clean and perfect, and for this purpose shall, at their own expense and in the presence of the Engineer or his appointee, provide suitable instruments and appliances and pass them through the pipes and shall if required, throw in water and show that it passes freely through every portion of the work. Brick, mortar and rubbish shall not be allowed to fall into the manholes of sewer lines while fixing or if allowed, shall be removed by the Contractors at their own expense.

Remedial Measures to be adopted by the Contractor

The Contractor shall take each and every precaution to ensure that the tunneling or drilling equipment will successfully excavate along the chosen pipeline alignment before he commences the operation. In the event of inability to complete the drive, due to break down or any other reasons, the Contractor shall be fully responsible to recover the equipment safely from the ground and restore the incomplete work to the original condition at his risk and cost by a method agreed with the Engineer and the concerned authorities within the time stipulated by the Engineer or the concerned authority.
The cost for such retrieval measures or any consequential expenditure or delays arising from thereof shall be entirely borne by the Contractor. Any failure of remedial measures shall be entirely at the risk and cost of the Contractor. Any abandoned hole or tunnel must be backfilled to the top of the hard

strata with concrete or gravel with grouting to provide a solid infill, or other method agreed with the Engineer completely at the Contractor's cost so as to prevent subsequent settlement.

Inspection and Replacement of Defective Work

(a) At any time during or after the execution of the Works the Contractor shall, at the request of the Engineer and within such time as the Engineer shall name, open for inspection any work covered up and should the Contractor refuse or neglect to comply with such request, he shall employ other workmen to open up same.

(b) If the said work has been covered up in contravention of the Engineer's instructions, or if on being opened up it be found not in accordance with the Drawings, Specification and Bills of Quantities or the instructions of the Engineer, the expenses of such opening and covering it up again, whether done by the Contractor or such other workmen, will be borne by and is recoverable from the Contractor.

(c) Wherever in the opinion of the Engineer the work done is inadequate or of poor workmanship or inferior materials or in any way sub-standard such works will be demolished, cut out and removed from the Works immediately and replaced with new materials of the required standard and quality at the Contractor's risk and cost.

Taking photographs

Contractor at his own cost shall take, print, supply album of photographs (Two sets) in an album during the construction work in progress. The photographs shall be submitted fortnightly or as directed by the Engineer. No extra payment shall be admissible for this requirement.

CCTV Survey

It is mandatory for the contractor to carry out CC TV Survey including submission of two soft copies & two hard copies to the Engineer after completion of particular drive / work along with manholes or as directed by the Engineer. No extra payment shall be admissible for this requirement.

Handing over of completed works

Any pipe or length of pipes found to be defective shall be immediately removed and replaced at the Contractor's expense and leaking joints shall be remade, the inspections and tests shall then be repeated as often as necessary until the whole line under inspection or test is accepted by the Engineer. Upon completion works and successful testing of completed works the same shall be handed over by the contractor to the user department under proper acknowledgement and certificate to this effect.

End of Part-10B